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MANAGEMENT DECISION MAKING FOR BLM NATURAL RESOURCES

Final Report

Charles D. Bonham
Range Science Department
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INTRODUCTION

The Range Science Department faculty at Colorado State University along with the Bureau of Land Management personnel has recognized for years that land management is a complex process involving simultaneous consideration of many variables. Furthermore, professional public land managers have recognized that the information necessary to properly evaluate any one given management alternative has been difficult to obtain. Yet, when multiple-use management is truly practiced the interactions of these several uses produce a number of problems to be solved by the manager. In addition to these long-existing complexities of land management, other problems have arisen as demands have increased for resource managers to quantitatively assess alternative management practices. Public land resource managers are required to show optimum use of the lands managed for the public's benefit. The information needed for calculations of optimum management strategies has simply been difficult to obtain. Furthermore, the staffs of the BLM management offices have previously-assigned priorities placed on the use of their time, and increased environmental concerns of the public demanding still more of their time.

The various BLM management staffs have already experienced some difficulties in planning for optimum land use and evaluating recommended management alternatives. Each new set of environmental conditions or change in the value of a product or management practice often requires a whole new data base. As an educator of natural resource managers, the Range Science Department is directly affected by the increasing complexities of multiple-use management as well. Given these complexities, it seemed that a joint undertaking by the BLM and the Range Science Department of

Colorado State University to evaluate management alternative decisions would be profitable for both parties. Thus, a research program was initiated to examine systems analysis techniques for their possible adaptation to the allocation of land resources under BLM jurisdiction.

Systems analysis techniques have not been used widely in the management of public lands; they have been used extensively in private farming and ranching enterprises. These techniques can permit both an evaluation of the full potential of each resource alone and in combination with all other resources, and a plan to minimize the adverse effects of any single use upon all others. However, an extensive evaluation has been made of systems analysis techniques applied to land management problems similar to those encountered by the BLM. In fact, it has never been guaranteed that systems analysis techniques, such as operations research, would be beneficial to land management planning.

BLM staff specialists have always allocated resources based on the suitability of the resource for any one use or combination of uses. However, the manual allocation process employed is very tedious and sometimes too slow for effective application. If systems analysis techniques could be used with greater speed and accuracy to evaluate a complex matrix of all resources of the ecosystem and their use characteristics, that technique would probably be accepted by the land management staff because it would allow a holistic approach to the management of BLM resources.

The planning system presently under implementation by the BLM was thought to be adequate. Nevertheless, it was agreed that use of quantitative techniques would assist the staff in decision making. In order to test this idea, this project was designed to evaluate the field use of an extension of the

present system. If it was found to be beneficial, then a training program for field personnel in its use as a management tool could be implemented. BLM personnel were to participate in developing the important ecological parameters for input into the testing procedure. This was to be accomplished by using the URA and MFP material supplied by the staff planning a management unit. The North Fork Planning Unit of the Montrose District was selected to develop and evaluate the systems analyses procedures. Data already available from the BLM included watershed, recreational potentials, environmental considerations, grazing of livestock and big game, and coal production, among others.

As stated in the proposal, this study could yield several benefits for BLM: (1) the development of a system to analyze many combinations of management alternatives; (2) the provision of decision-making tools allowing profit maximizing or cost minimizing decisions without imposed constraints regarding the manager's wishes for maintaining the aesthetic environment and for protecting valuable watersheds; (3) the evaluation of management alternatives on resource uses; and (4) the development of a system providing for the storage of inventory information and assisting in management decision making.

The major research effort was placed on the first item listed above. At the request of BLM personnel, decision-making tools for profit maximization and cost minimization were not developed since the agency does not emphasize this aspect of management; this aspect could easily be included if needed, however. A determination of the effects of certain management alternatives on other uses for the same resource was a by-product of the work accomplished on item (1) above. The last item of possible benefit, the development of a system which would provide for storage of inventory

information, explored through a separate contract with another organization. The system subsequently developed, designated the CRIS (Comprehensive Resource Information System), is currently being implemented by BLM.

The primary objective of this study was to suggest a method to enable BLM decision makers to compare a multitude of alternative management strategies and uses to determine the strategy which would best meet the needs of society. The tools developed do not provide a solution to all management problems; they can, however, greatly increase the reliability of management decisions by providing a quantitative framework within which necessary management goals can be made much more explicit in the planning process. It must be emphasized that throughout the design and implementation stages of the project, concerted efforts were made to develop methodologies consistent with the URA-MFP system currently in use by the Montrose District (Colorado) of the BLM. In addition, we attempted to capitalize on the knowledge, experience, and expertise of BLM personnel and utilized a few standard "textbook" approaches when necessary.

The results and suggestions contained in this report are based upon the premise that sound planning decisions can be made only if: (1) critical planning variables and constraints can be identified and their probable scope and magnitude outlined; (2) reliable and comprehensive data on the existing conditions in the management unit are known; and (3) potential impacts of all management alternatives can be identified. Attainment of these goals requires that information and data inputs be in a form that the management staff understands.

It must be emphasized that the central purpose of this project was to provide better information for resource decision makers. This goal was stressed because the final output of this research must be information that can and will be used in BLM resource planning decisions.

It was initially anticipated that this study would have at least six major steps: (1) the development of existing BLM inventory data for a planning unit; (2) the determination of the potential production capability for individual resource outputs; (3) coordination with the BLM planning system; (4) study of the interactions of various output possibilities; (5) sensitivity analysis for each management alternative; and (6) preparation of an operational plan for a BLM planning unit.

THE NORTH FORK PLANNING UNIT

The North Fork Planning Unit is located in eastern Delta and northwestern Gunnison Counties of Colorado, bounded by the Grand Mesa National Forest on the north and the Gunnison National Forest on the northeast, east and southeast. The unit contains a total of 109,246 acres of which 63,723 acres are public domain managed by the Bureau of Land Management. The area adjacent to the North Fork of the Gunnison River and the areas surrounding the towns of Hotchkiss and Paonia consist almost exclusively of patent lands. Most of the lands near the perimeter of the unit are public lands.

The climate of the planning unit varies from xeric to mesic as the elevation varies from 5400 feet on the lower reaches of the North Fork of the Gunnison River to 8600 feet above the Paonia Reservoir. Annual precipitation varies from 10 inches to over 25 inches between the elevation extremes; two-thirds of the precipitation occurs from October to April and is mostly in the form of snow. Average annual temperature for the unit is 47.5°F.

Diverse topographic features characterize the North Fork Planning Unit. The lower portion of the planning unit has broad, nearly-level to moderately-sloping valleys, flanked by low, rolling hills or adobe bajadas. These adobe hills break rather abruptly into moderately- to steeply-sloping mesas which are highly dissected by steep drainageways or canyons. Flat or sloping mesas and ridges which were built up from alluvial deposits (basaltic), comprise the upper portion of the unit. Above the mesas on the northeast and on the south are steeply-sloping dissected plateaus which extend to the head-waters of the major streams. The streams are shallow at this elevation and the topography is typified by gently- to strongly-sloping valleys. These

valleys are interspersed with steeply-sloping, smooth, rolling hills on the northern boundary and very steep, rough glaciated peaks on the southern boundary of the unit.

The diverse topography compounded with the broad range in elevation causes great and often abrupt variations in vegetation associations. Vegetation varies from the low desert ranges on the alkali flats to the subalpine type near the small towns of Cedaredge and Eckert. This transition occurs more gradually over the rest of the unit.

LINEAR PROGRAMMING

Linear programming was the first of the mathematical programming techniques to be developed and the first to be solved with a computer algorithm. Dantzig worked out the first solution algorithm in 1947. This algorithm is the most commonly used and is referred to as the Simplex method. The main use of linear programming has increased since the computer has reduced solution times of a problem from several man-days to a few seconds. Several good computer codes for solving linear programming problems are available in most computer center library files.

Basically, the technique obtains the maximum or minimum value of some *objective function*, a linear combination of a set of variables. This objective function may be described by the land manager using the linear programming technique. A series of *constraints* to the problem limits the numerical values of the variables. In linear programming these constraints are also linear functions of the variables. In some physical applications of linear programming, non-negativity constraints prevent the variables from taking negative values. The linear programming format may be stated in matrix notation as in the equation:

$$\max\ (\min)\ \ \underset{\sim}{C}^T \underset{\sim}{X}$$

$$\underset{\sim}{A}\underset{\sim}{X}\ (\lesseqgtr)\ \underset{\sim}{b}$$

$$\underset{\sim}{X} > \underset{\sim}{0}$$

The variables are represented by the vector $\underset{\sim}{X}$. The coefficients in the linear objective function of the variables in $\underset{\sim}{X}$ are noted by $\underset{\sim}{C}^T$, where the $\underset{\sim}{C}^T$ is the transpose of the row vector $\underset{\sim}{C}$ and is, therefore, a column vector of constant coefficients. The matrix $\underset{\sim}{A}$ is the constraint matrix

which, when multiplied by the variable vector $\underset{\sim}{X}$, gives a linear combination of the variables which must be greater than or less than certain other constants which are represented in vector form by $\underset{\sim}{b}$. The non-negativity constraints are represented by the vector $\underset{\sim}{X}$ being greater than or equal to the vector $\underset{\sim}{0}$ which implies that each of the variables in the $\underset{\sim}{X}$ vector is greater than zero.

The solution to linear programming problems may be obtained using graphical techniques when there are only two or three variables. In this case, we want to select values of x_1 and x_2 which will give us the maximum value for f(x). However, there are also some constraints on the selection of values of x_1 and x_2. These constraints are usually expressed in the form of inequalities which indicate that values of x_1 and x_2 to be chosen to maximize the objective function must simultaneously satisfy the inequalities.

The objective function, which is also a linear combination of the x values, is a family of straight lines. The maximum value of the objective function that satisfies the constraints is the point represented by the combination of the constraint equations that gives the maximum value for the objective function. In linear programming, this point is always one of the vertex points of the *convex set* which is bounded by the constraint equations. The line that gives the maximum value is the one that intersects the convex set furthest to the right on a graph. This point is one of the vertices formed by the boundary of the convex set.

The Simplex solution algorithm for linear programming problems is based on this fact that the best solution for the objective function in a linear programming problem always occurs at one of the vertices of the

boundary determined by the constraint equations. The solution thus involves moving from vertex to vertex in such a way that the value of the objective function is always increasing and stopping at the vertex which gives the maximum value of the objective function.

As previously mentioned, the objective function and constraints in linear programming problems are always linear functions of the variables. It follows that the coefficients are not direct functions of the variables and thus the variables appear in the equations in first order terms (i.e., there are no powers other than unity for the variables). All equations are assumed to be deterministic and the problems are static since none of the variables change over time. If these conditions are not satisfied, then the problem is no longer linear and this technique cannot be used.

Two other key linear programming concepts are *duality* and *sensitivity analysis*. The duality condition states that for every maximization problem there is a corresponding minimization problem which has exactly the same solution value as the maximization problem. The opposite is also true. Duality usually plays an important role in sensitivity analysis which is performed to find out how much the objective function can be changed without changing the point at which the optimal solution to the problem occurs. This procedure is sometimes used to find out how much the $\underset{\sim}{b}$ vector in the constraints can be changed without changing the value of the objective funtion in the dual problem. It may be of interest to change the coefficients in the objective functions in the dual problem, a process equivalent to changing the $\underset{\sim}{b}$ vector in the constraints of the original problem to find out how sensitive the solution is to changing the $\underset{\sim}{b}$ vector.

The Simplex algorithm for linear programming is probably the simplest technique available to solve a mathematical programming optimization problem. More realism can be added to the problem by making some of the constraints or objective function nonlinear. This can be accomplished by adding random elements into the problem or by including time as an explicit variable. These procedures usually increase the complexity of the solution technique. Therefore, in applications of linear programming, a choice frequently exists between simplifying the problem or adding more realism and thus more difficulty in obtaining its solution.

A number of practical problems were encountered in the use of linear programming for resolving BLM natural resource management problems, such as: (1) the allocation of appropriate resource uses to identifiable geographical areas after an optimum solution had been obtained; (2) homogeneity requirements for each land area designated as producing the same level of resources; and (3) once the resource was utilized for a given acre for one use (e.g., forage for livestock, wildlife, etc.), that acre could not be used for any other resource. Yet, we know that in reality a given acre can be used for several products. These and many other irresolvable problems caused us to look at other mathematical programming techniques as tools useful in BLM decision making. Goal programming was selected as the best technique for management use. Since an extensive report was filed on linear programming in April, 1973, only results of Goal Programming are given in the Final Report.

GOAL PROGRAMMING

Considerable doubt has been cast as to whether an economic approach to management can be applied by the decision maker in today's complex organizations (Lee, 1972). It has already been acknowledged that the BLM's land management program involves complex problems. Therefore, some other method of analysis to select appropriate alternative management strategies must be taken.

No one can perform a completely rational environmental analysis of complex problems; one's value orientation influences any such analysis. It is unlikely that the analyzer's value system is identical to that of the public. Thus, the decision maker is likely to be incapable of making the optimum management choice for the public because of the problems involved are so value laden as well as complex.

In reality, the BLM resource manager attempts to attain a set of goals for the management unit to the fullest extent possible in an environment of conflicting interests. This task is further complicated by the fact that available information is often insufficient, manpower resources are limited, and additional limitations are placed on him by various sectors of the public. The primary difficulty in decision making is thus the analysis of multiple, conflicting objectives and the development of meaningful action programs which can be implemented. Therefore, a formal decision analysis that is capable of handling multiple, conflicting goals through the use of priorities is desirable as an aid to BLM decision making for natural resource management.

Goal programming appears to be an appropriate technique for analyzing problems that have multiple, conflicting objectives. Goal programming allows for a solution to a system of a complex set of multiple objectives,

whereas linear programming allows for the solution of only one objective at a time if even that one solution can be obtained. Goal programming thus allows for a more all-inclusive analysis, so climatological, ecological, and sociological as well as economic parameters can be weighed in decision making, offering more understanding and control over environmental and ecological conditions.

We deliberately departed from the traditional concept of man as an economic manager since it suggested that he is a financial optimizer and is further assumed to be one who strives to allocate scarce resources in the most economical manner. While the economist may have some knowledge of the relevant aspects of environmental characteristics, we assumed that economic values are not critical in selection of management alternatives for implementation on public lands managed by BLM.

The process of decision analysis must have at least three characteristics: (1) consideration of management goals and environmental constraints; (2) an explicit analysis of relationships that exist between all variables (environmental, ecological, etc.) in the model; and (3) verifiable outcome of the optimum course of action. This approach to management goals provides the foundation for decision making and the ultimate selection of alternative practices for land management. These goals often dictate that constraints will be placed on using certain management practices because environmental factors such as precipitation, soil-vegetation resources, topographic features, etc. cannot always be controlled. Thus, management goals are usually formulated based on these environmental constraints.

Objectives or goals of management must be clearly identified along with realistic activities to attain these objectives and goals in order for a

decision to be made. Decision making for BLM planning units has always required identification of goals during the planning process. After goals have been determined, the next step has been to find a means to accomplish them. Since it is the decision maker's task to evaluate the consequences of various possible courses of management action, either he must be very knowledgeable about the available resources or have specialists on his staff who are capable of evaluating the various management alternatives with respect to specific resources. Finally, one of the examined alternatives must be chosen. This final stage has often required a considerable degree of judgement in the past.

Goal programming is not a substitute for experienced decision planning, but it does enable the decision maker to be more systematic in attaining and justifying his goals. The technique will allow the decision maker to balance desires of the public sector in the management of their land with the resource capabilities of the land.

The selection of priority ratings to be placed on the goals becomes the first decision problem faced by the manager. Obviously, there are conflicting interests in the resource uses and the manager must assign priorities according to what in his view represents the desires and needs of the public involved with the management unit under consideration. It is suggested that goal programming is an appropriate as well as flexible technique for weighing management alternatives with respect to multiple, conflicting objectives which exist under numerous environmental constraints. Goal programming allows for simultaneous solutions to be obtained from a set of multiple objectives. Furthermore, it is capable of handling decision problems that deal with a single goal with multiple subgoals, as well as

with problems with multiple goals and multiple subgoals. The approach assumes that the lower-order goals are considered only after the higher-order goals are satisfied or have reached the desired limit. In contrast to linear programming, goal programming attains the goals as closely as possible rather than obtaining an absolute solution to a single objective function.

In contrast to goal programming, the primary difficulty with linear programming is that it usually requires cost or profit information in the objective function that is often impossible to obtain and is often of no interest to the decision maker. To overcome the uni-dimensionality of the objective function required in linear programming, efforts have been made to convert various goals or value measures into one criterion, namely utility. Even if this could be achieved, the exact measurement of utility is not a simple matter and there is no methodology to develop a utility function. Thus, decision making through linear programming by way of a utility function is only feasible in a theoretical sense. Goal programming eliminates this problem.

Goal programming is really a modification and extension of linear programming. In addition, the objective function of a goal programming model may be composed of a non-homogeneous measure such as pounds of forage and tons of sediment rather than one type of unit. As previously mentioned, linear programming has the restriction that only one use of a resource is obtained from a unit area. Fortunately, goal programming does not have this constraint.

If a manager can provide a ranking of goals in order of their importance to him, management problems can be solved by goal programming. Instead of

attempting to maximize or minimize the objective criteria as in linear programming, deviations in attaining a goal within a set of constraints can be minimized. Then the objective function becomes the minimization of these deviations based on their relative importance or priority assigned to them by the decision maker. Furthermore, goal programming allows for an upper and lower limit to be stated for each subgoal or goal. Thus, the real value of goal programming is the solution of problems involving multiple and sometimes conflicting goals according to the priorities listed either by the public, the agency (BLM) or both.

Incompatible multiple goals exist more often than not and therefore it is important for the manager to recognize that he must exercise his judgement about the importance of the individual goals. That is, the most important goal must be achieved to the extent that the manager desires before the next goal is considered. Goals in this sense may simply be a meeting of a certain set of constraints. For example, the manager may set a goal of stabilizing the number of deer able to graze in a certain winter range area. In this case, the goal is a part of the constraint. In other cases, the goal may be an entirely separate function of the constraints of the system. In any event, when all constraints and goals are completely identified, each goal must be analyzed to determine whether over or under achievement of a goal is satisfactory. Based on this analysis, the decision maker can assign deviational variables to the goal constraints. If over achievement of the goal is acceptable, positive deviation from the goal can be eliminated from the objective function. If under achievement of a certain goal is satisfactory, negative deviations should not be included in the objective function. If the exact

achievement of the goal is desired, both negative and positive deviations must be represented in the objective function.

In order to achieve the goals according to their importance, negative and/or positive deviations about the goal must be ranked according to their preemptive priority factors. In this way, the lower-order goals are considered only after higher-order goals are achieved. Deviation variables can be weighted if it is important to minimize one particular deviational variable or maximize the deviation variable.

In general, a goal programming model performs three types of analysis: (1) it determines the input requirements to achieve a set of goals; (2) it determines the degree of attainment of defined goals with given resources; and (3) it provides the optimum solution under the varying input and goal structures. A most important advantage of goal programming is its great flexibility which allows model simulation with numerous variations and constraints in goal priorities, accomplished by simply changing goal priorities or constraints, or both, and running the model through the computer again. It should be recognized that the goal programming model simply provides the best solution under the given set of constraints and priority structure. Therefore, if the decision maker's goal priorities are not in accordance with the desires and/or demands of society, the solution will not be optimum for that sector of society expressing its wishes.

The application of goal programming for managerial decision analysis does force the decision maker to think of goals and constraints in terms of their importance to BLM responsibilities for land management. As other mathematical programming techniques, goal programming has some

limitations. The most important limitations include the assumptions made with regard to the relationship among the variables and their constraints. For example, the optimum solution may result in non-integer values for the decision variables, say 519.2 deer. These must be accepted as being optimal rather than some integer value, say 519. This probably does not have serious consequences on the output and is of no practical concern. Another limitation of goal programming is the deterministic output. In other words, the problem requires a solution in a static decision environment, when in reality the decision environment is always dynamic. Therefore, technically speaking, the coefficients in the model are neither known nor constant. However, it should be pointed out that this problem exists in the decision-making process, whether goal programming is used or some manual procedure is used by the manager. Thus, it would seem that in practical goal programming there are fewer limitations than with its counterpart, the subjective evaluation procedure.

Again, the objective is to minimize deviations from the goals. Thus, the value of the deviational variable associated with the highest preemptive priority must be minimized to the fullest possible extent. When no further improvement is possible or desired in the highest goal, then an attempt is made to minimize the value of the deviational variable associated with the next highest priority goal and etc. until the last goal or low-priority goal is analyzed.

The above summary of goal programming admittedly cannot replace a full-text explanation of the procedure. Rather, it was intended to present some basis for using goal programming in BLM decision making. Since it is impractical to give the complete goal programming model

formulation procedures in this report, it is suggested that personnel receive training in order to implement these procedures into the BLM decision-making process (Figure 1).

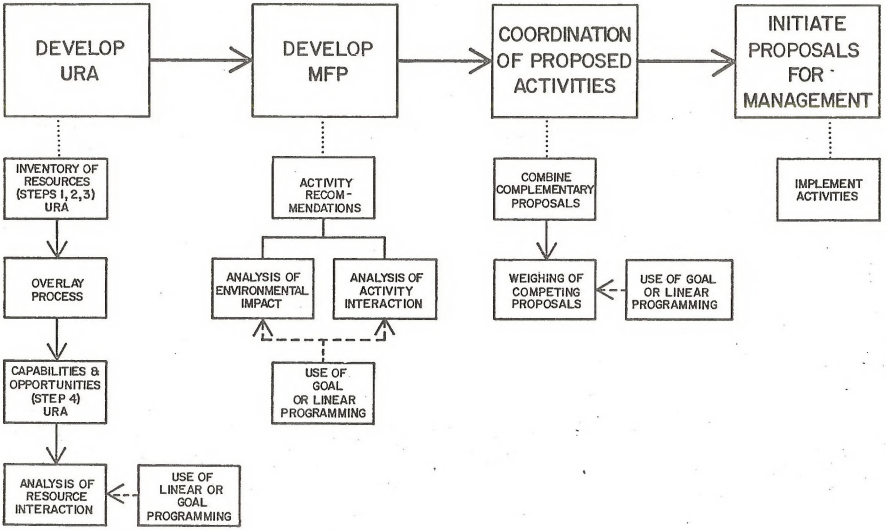


Figure 1. Utilization of linear and goal programming in BLM planning system.

FACTORS CONTROLLING MODEL SIZE AND HOMOGENEOUS ECOLOGICAL RESPONSE UNITS

The availability of decision-making tools such as goal programming offers excellent opportunities for analyzing the complex interactions existing between natural resources and their utilization. However, even these new computer tools have limitations as to the problems that they can help solve. One of the first considerations in using such tools is the formulation of the problem to be analyzed so that these techniques are useful for obtaining answers. There are four major factors which control the level of data input that determines the size of the problem: (1) the number of resource products produced and utilized on a specific area of land; (2) the number of management alternatives available to alter resource production and utilization; (3) the degree of ecological homogeneity of the management area; and (4) the geographical size of the area to be analyzed.

As any one of these factors increases, the size of the model will also increase. This becomes a problem only if the model is already near its maximum size as determined by the computer capability. The four factors must all be included together so as one factor increases in size the other three are reduced. This point is clarified later. The manager may be faced with balancing the size of each of these factors so that the optimum management analysis can be obtained. A discussion of this tradeoff procedure follows.

The number of potential uses and management alternatives for natural resources are already large and still growing in number. Fortunately, the actual demands on a specific area of land are often limited to a few major

uses with a limited range of possible management alternatives. The exact number of uses for a specific area depends on the products which can be produced by the land. Water, livestock and wildlife forage, minerals, recreational opportunities, building sites, and timber are among the more common products. The location of the resource production, the rates of production and utilization must be known before a product can be included in the management analysis. The degree to which the rates of production and utilization will be affected by each management alternative must also be known as these facts become important inputs into the problem analyses. It is thus apparent that each time a new management alternative is considered or an additional product is considered for utilization, the size of the problem for the specific area increases.

There are several guidelines for deciding whether to include a particular management alternative or utilization of a specific resource product. Certain resource uses and management alternatives are directly related or even in direct conflict with each other. These correlations must be included in the model. For example, sheep and deer may be in competition for the same forage, while the management alternative of brush control for livestock forage may affect watershed characteristics such as runoff. An area may be used almost entirely for the production of one product under one management alternative (as clearcutting of timber, surface mining, or intensive livestock production), but it could be of such scale as to alter the basic ecosystem's vegetative condition, soil stability, or water quality. Such an alteration may affect neighboring areas and, for this reason, it could be included in the model.

There are instances where two or more uses are in direct competition but there may not be any need to include them in the model. For example,

an area may be of high scenic or historic value, contain stip-mineable coal, and offer excellent sites for summer homes. In such a case, there is little room for multiple use and the manager must select which alternative use the land will have. Once this choice is made, the area of land is no longer available for many other uses and may be left out of the problem formulation entirely. Another example is an area which is one of the few remaining habitats for an endangered species of bird. If it were decided that this habitat must be maintained as is, other potential uses and management alternatives, although feasible on other grounds, would not be included in the model for that area.

Separation of potential uses by time could help simplify the overall management problems. A high level of off-the-road vehicle use for recreation could be in serious conflict with wildlife. Such a conflict could require extensive analysis to determine areas and levels of use. However, if the primary vehicle was the snowmobile and the wildlife grazing took place in the summer, then there would be little need to include the snowmobiling activity in the model. While these examples are simple, they point out the need to exclude complications when possible.

The number and types of resource uses and management alternatives that can be considered are largely a function of the ecological parameters of the management area. The interactions between the various ecological parameters and each of the resource uses and alternatives are so complex that the total impact cannot be included in the analysis. The most important uses, management activities, and important ecological parameters must be identified by the manager. The more ecological parameters, such as soil

type, slope, vegetation, that are included, the larger and more complex the problem will be. For instance, a foothills area will be more complex than a grassland region. Therefore, a model for a grassland area can either include more ecological parameters or cover a larger geographical area.

The last factor discussed in relation to model size is the geographical area under study. The more acres of land included in a single model, the larger the model must be. This is perhaps the easiest factor of input for the manager to control and in some cases the only one he can control. The resource products and management alternatives are relatively fixed and the ecological diversity is fixed. If both of these factors are high then there is little choice but to limit the area under consideration for a single model.

Developing a model of acceptable size that can answer the key resource management questions is based on the interaction of the three factors just discussed, resource use and management alternatives, ecological parameters, and geographical size. It would be of considerable help if the manager had a means of merging these factors so as to arrive at values to put into the model. One approach is identifying what we chose to call "Homogeneous Response Units" and using units as a focal point for data input. The explanation of "Homogeneous Response Units" can best be made with an example of an actual area of natural resource lands from the North Fork Planning Unit.

An area in the foothills of the Unit was selected as a test unit because of its high diversity in ecological parameters, resource uses, management alternatives and its size (10,629 acres). The examination of

this area will be carried through the whole sequence of model building and analysis. The process will serve as a detailed example of the problems discussed earlier in model (problem) size and will explain the use of "Homogeneous Response Units" in collecting data for model analysis. We will use goal programming to obtain some illustrated solutions.

The area used is east of the town of Paonia and contains three cattle grazing allotments, 28, 29, and 30 North (Figure 2). The inclusion of these three allotments will illustrate the division of a larger planning unit into three subsystems. All three of the allotments contain deer and elk range and are part of the watershed of the North Fork of the Gunnison River. In addition, allotment 28 contains coal reserves. Management alternatives discussed in the URA include grazing management, brush control, big game hunting, cattle grazing and coal mining. The area also offers some scenic value. During the remainder of this discussion this area will be referred to as the "planning unit".

Once the boundaries of the planning unit were set, the unit was divided into a series of "Homogeneous Response Units." The first step was to select the ecological parameters that were considered to be the most important in the production and utilization of resources in the planning unit. The main resource products for this unit are forage for wildlife and livestock, water and sediment, and coal. The ecological parameters are soil type, vegetation type, terrain slope, and erosion status. These four were selected because the BLM methods used for estimating the resource products under consideration are functions of these four ecological parameters. (The use of the parameters in estimating resource production will be covered later.) Also, information on the

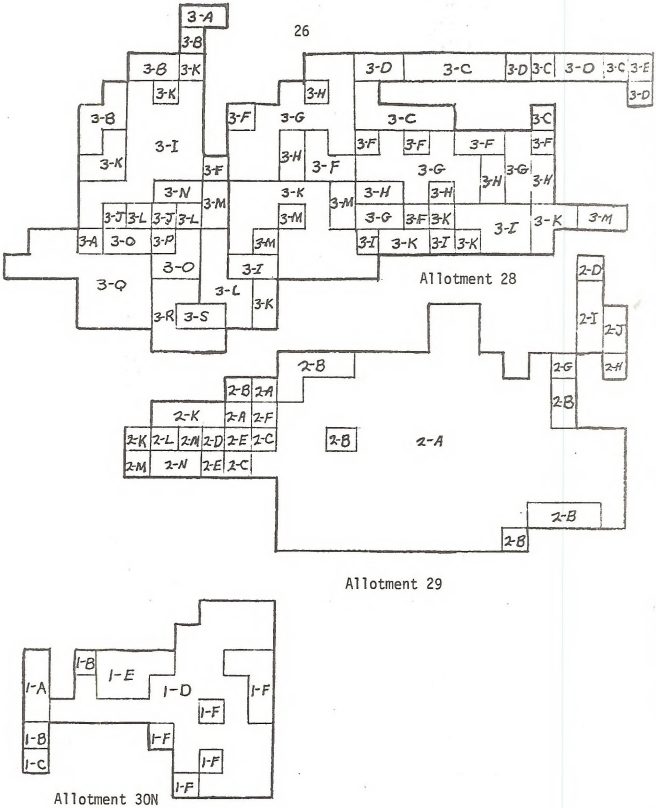


Figure 2. The division of the watershed into "Homogeneous Ecological Response Units".

parameters was obtained from the URA and its accompanying overlays. Additional slope information was obtained from standard geological survey maps of the area which was not available in the URA, but is definitely an important component for ecological responses in an area.

A grid system was placed over a map of the planning unit which divided the unit into arbitrary 25-acre squares. This facilitated the collection of slope data as well as determined the area covered by each "Homogeneous Response Unit." This procedure provided a reference system for computer mapping to generate various overlays to recreate the response units.

The next step was to classify each one of the 25-acre grids on the basis of the four ecological parameters. If two or more grids were contiguous and identical in their ecological parameters, they were lumped together and their areas summed. The resultant area was considered homogeneous and designated as a "Homogeneous Response Unit." If an area is entirely homogeneous, the rates of production of the various resource products will be the same throughout the whole response unit. The whole unit will also respond in the same manner to a management activity or alternative. Furthermore, if two or more "Homogeneous Response Units" within the same planning unit have the same ecological parameters then a production rate for a variable on one acre of the response unit can be used in the model as the rate for the whole "Homogeneous Response Unit."

We assumed that a "Homogeneous Response Unit" was, in fact, homogeneous in all aspects. We do not need to measure every possible ecological parameter and compare them for homogeneity. In fact, the homogeneity assumption is necessary in most management situations. For example, two areas may vary

somewhat in vegetation and still produce approximately the same amount of sediment or forage. The question for the manager then is how much can the rates of production between two units vary before it is unacceptable to call them homogeneous.

Determining the necessary degree of accuracy of data on ecological parameters is a central problem. For example, the slope of the terrain in a 25-acre unit varied from 0 degrees to greater than 45 degrees. Obviously, a grid unit with a 40-degree slope cannot be considered homogeneous to one with a 35-degree slope. On the other hand, for most management purposes, a 10-degree slope and a 12-degree slope can be classed together. How great can the difference in slope be before the units can no longer be considered homogeneous ecologically? The safe choice would be to obtain the most accuracy for the methods and resources available, but this could result in serious problems in keeping the model size within reasonable limits. This difficulty can be seen by examining the number of possible "Homogeneous Response Units" that result from using the four ecological parameters at various levels of accuracy. For instance, the parameters are divided as follows:

1. Slope
   a. 0-15 degrees
   b. 16-25 degrees
   c. > 25 degrees

2. Soil
   a. Brown chestnut
   b. Mountain prairie

3. Erosion condition
   a. Stable
   b. Moderate
   c. Critical

4. Vegetation
   a. Pinyon-juniper
   b. Sagebrush
   c. Mountain shrub
   d. Shadscale
   e. Broadleaf trees

From this broad classification of the four ecological parameters, it is possible to obtain 90 different "Homogeneous Response Units." The above classification was used for our discussion.

There are data available for more accurate classification. There could have been five levels of erosion, seven levels of slope, and 16 vegetative classes in addition to the two soil types for the selected unit of study. These classifications would generate 1120 possible response units. Although such detailed information could greatly increase the accuracy of the analysis, it would cause two problems. First, as indicated earlier, the more ecological parameter information there is, the larger the model will be. If the model becomes too large for available computer capacity, then either the number of uses or the area size must be reduced. The second problem will become fully apparent when the determination of production rates for all response units is discussed. Briefly, can the manager determine the difference in production rates between two response units that differ by, say, two or three degrees in slope or have slightly different vegetative composition? The existing methods used in the URA do not permit such refinement, nor do we believe it necessary to obtain additional field measurements in order to achieve these refinements.

CALCULATIONS OF COEFFICIENTS

The successful use of mathematical programming techniques for weighing alternative decisions by the resource manager depends on the availability of accurate resource data for use in the model as coefficients. These coefficients are essentially divided into five classes:

1. The current status of the available flow resources such as forage (lbs/acre), mineral reserves (tons/acre), water runoff (acre ft.), etc. In other words, how much of each resource is available now for use? These resources are associated with a unit area such as an acre or other acceptable area measurements.
2. The utilization rates of the resource products by various users. This applies to animal consumption of forage, levels of recreational use such as number of hunter days per unit area, or water accumulation (consumption).
3. The levels of production and use for each resource for the planning area must be assumed or actually known. These values could be based on current actual use or on a future desired rate of use. Examples include cattle AUM usage in existing grazing permits, desired water yield from a watershed, or maintenance of the deer herd at its present size. These values are used as the right-hand constraints in both goal programming and linear programming.
4. Management activities affect the rate of production and utilization of the flow resources in various ways. These effects are expressed as increases or decreases in the available resources per unit area. For example, how much does brush control affect the production of soil sediment in run-off water or how much increase in herbage occurs as brush is eliminated?

5. If goal programming is used, the various resource alternatives must be ranked according to their relative importance. These values must be determined by the BLM staff planning the unit and such priority derivations are usually based on the various local, regional and national priorities. These ratings are relative, can be derived from public hearings, and can be changed to study the various trade-offs that occur when one use has a priority goal over another.

We used resource information already collected by the BLM for the URA and MFP reports to calculate needed coefficients. Methods for collecting the required model resource coefficients are explained in the appropriate BLM manuals. A general survey of the relationship between the various coefficients, management alternatives and BLM manuals is given in Table 1.

The data collected and analyzed using the methods indicated in the BLM manuals are recorded on a series of specific BLM forms. For example, form 7310-12 is used to determine erosion condition class. Most of the detailed information on these forms is condensed and included in the URA and its associated overlays. Since the original data forms were not readily available to us, we used the URA information to obtain the coefficients. If the URA was lacking in sufficient information on a resource, the required data were estimated using the methods indicated in the appropriate BLM manuals.

The coefficients for all resources, uses and management activities need to be obtained for each of the various "Homogeneous Response Units." In the specific examples of goal programming analysis presented later in this report, the response units were based on four factors: vegetation type, soil type, slope, and erosion class. This resulted in 39 response

Table 1. BLM manuals for determining resource coefficients

Resource	Coefficient	Source
I. Watershed	1. Sediment 2. Runoff 3. Erosion condition	BLM Manual 7313 (Cover) BLM Manual 7317 (Erosion) BLM Manual 7322 (Watershed Conservation)
II. Forage	1. Production by vegetative type 2. Range suitability 3. Forage availability	BLM Manual 4412 (Forage Survey) " " " " " " " "
III. Wildlife	1. Diet by season 2. Compatability with livestock	BLM Manual Tech. Supplement 6601-6
	3. Habitat inventory	BLM Manual 6611 (Extensive Inventory) BLM Manual 6612 (Intensive Inventory)
IV. Timber	1. Allowable harvest	BLM Manual 5240 (Allowable Cut)
V. Recreation	1. Opportunities	BLM Manual 6111 (Quality Evaluation)
	2. Visitor use	BLM Manual 6112 (Visitor Use Analysis)

units (Figure 2). The various resource coefficients for each of these response units were then determined (Table 2). The method of coefficient derivation is summarized below:

1. Scenic value categories were taken from the Recreation section of the URA and were based on vegetation and topography:

Scenic Category	Description
1	Aspen and conifers
2	Mountain brush
3	Pinyon-juniper
4	Sparse vegetation
5	Disturbed lands

   If a particular response unit is subjected to extensive brush control, the unit's scenic coefficient has changed from its URA value to a 5 (disturbed lands) in the model.

2. The sediment yield coefficient was based on tons per acre. This information was not available in the URA and estimated values were calculated for each response unit by using the Pacific Southwest Interagency Committee method outlined in BLM Manual 7317. This method involves calculation of a sediment yield factor rating which is used to estimate the sediment yield (Table 3 and Figure 3). The erosion data used in Table 3 were obtained from the URA and are recorded on Form 7310-12, "Determination of Erosion Condition Class," and Form 7310-10, "Ground Cover Transect Data Sheet." The surface geology, soil data, climate, and land use information were also collected for the URA and recorded on overlays as well as in narrative form. The forms containing the erosion data were not available, but the erosion condition class for

Table 2. Response units with flow resource coefficients.

	Row	Response Unit Number																	
		30N 1A	30N 1B	30N 1C	30N 1D	30N 1E	30N 1F	29N 2A	29N 2B	29N 2C	29N 2D	29N 2E	29N 2F	29N 2G	29N 2H	29N 2I	29N 2J	29N 2K	29N 2L
Acres	1	75	50	25	725	125	200	2700	300	50	50	50	25	25	25	75	50	100	25
Vegetation	2	SB[1]	PJ	PJ	MS	MS	MS	MS	MS	MS	PJ	PJ	PJ	SB	SB	SB	SB	MS	MS
Soil	3	BC[2]	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	BC	BC
Slope	4	0-15	0-15	0-15	0-15	0-15	15-25	0-15	16-25	16-25	16-25	0-15	0-15	16-25	16-25	0-15	>25	16-25	0-15
Erosion class	5	STA[3]	STA	MOD	STA	MOD	STA	STA	STA	MOD	MOD	MOD	STA	STA	MOD	MOD	MOD	STA	STA
Acres with coal	6																		
Scenic rating	7	4	3	3	2	2	2	2	2	2	3	3	3	4	4	4	4	2	2
Acres deer winter range	8	75	50	25	725	125	200	75	25			25		25	75	50			
Acres elk winter range	9				300		150	75	25			25		25	75	50			
AUM's grass & forb/acre	10	.10	.02	.02	.145	.145	.145	.13	.13	.13	.02	.02	.02	.10	.10	.10	.10	.13	.13
AUM's browse/acre	11	.10	.03	.03	.105	.105	.105	.20	.20	.20	.03	.03	.03	.10	.10	.10	.10	.20	.20
Tons sediment/acre	12	.88	1.13	1.75	.75	1.50	.63	.75	1.13	1.75	2.25	1.75	1.13	1.25	2.00	1.50	2.50	1.13	.75
Acre-feet runoff/acre	13	.01	.015	.025	.01	.017	.01	.01	.01	.017	.025	.025	.015	.010	.017	.017	.017	.01	.01
Grazing management																			
Runoff	14	.008	.012	.02	.008	.014	.008	.008	.008	.014	.02	.02	.012	.008	.014	.014	.014	.008	.008
Sediment	15	.66	.85	1.32	.55	1.10	.47	.56	.85	1.30	1.69	1.30	.85	.936	1.30	1.30	2.30	.85	.56
Grass & forbs AUM's	16	.13	.05	.05	.18	.18	.18	.153	.153	.153	.043	.043	.043	.123	.123	.123	.123	.153	.153
Browse AUM's	17	No	Change																
Brush control management																			
Runoff	18	.007	.01	.019							.018	.018	.011	.007	.012	.012	.012		
Sediment	19	.62	.79	1.23							1.44	1.12	.74	.81	1.28	.98	1.75		
Grass & forbs AUM's	20	.25	.17	.17							.16	.16	.16	.24	.24	.24	.24		
Browse AUM's	21	.15	.08	.08							.073	.073	.073	.143	.143	.143	.143		
Scenic rating	22	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Hunting management																			
Success rate-deer	23	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	5.8	.58	.58	.58	.58	.58
Success rate-elk	24	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30
% Res. harvest-deer	25	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43
% Res. harvest-elk	26	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60
% Non-res. harvest-deer	27	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57
% Non-res. harvest-elk	28	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40
Res. hunter days-deer	29	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17
Res. hunter days-elk	30	6.27	6.27	6.27	6.27	6.27	6.37	6.27	6.37	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27
Non-res. hunter days-deer	31	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91
Non-res. hunter days-elk	32	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63
Coal mine																			
Sediment	33																		
runoff	32																		

[1]Vegetation
SS = sagebrush
PJ = pinyon-juniper
MS = mountain shrub
BT = broadleaf trees
SS = shadscale

[2]Soil
BC = brown chestnut
MPC = Mountain prairie, chestnut

[3]Erosion class
STA = stable
MOD = moderate
CRT = critical

Table 2. (Cont.)

	Response Unit Number																					
Row	29N 2M	29N 2N	28N 3A	28N 3B	29N 3C	28N 3D	29N 3E	28N 3F	28N 3G	28N 3H	28N 3I	29N 3J	29N 3K	28N 3L	28N 3M	28N 3N	28N 3O	28N 3P	28N 3Q	28N 3R	28N 3S
1	50	50	75	175	300	150	25	300	750	250	750	50	950	175	200	50	150	25	425	150	50
2	PJ	PJ	PJ	PJ	BT	BT	BT	MS	MS	MS	PJ	PJ	PJ	PJ	PJ	PJ	SS	SS	SB	SS	SS
3	BC	BC	BC	BC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	MPC	BC	BC	BC
4	16-25	16-25	0-15	16-25	0-15	16-25	>25	0-15	16-25	>25	0-15	0-15	16-25	16-25	>25	>25	0-15	16-25	0-15	0-15	16-25
5	STA	MCD	STA	STA	STA	STA	STA	STA	STA	STA	STA	CRT	STA	CRT	STA	CRT	CRT	CRT	STA	CRT	CRT
6					300	150	25	225	675	200											
7	3	3	3	3	1	1	1	2	2	2	3	3	3	3	3	3	4	4	4	4	4
8					75			175	350	175	425		800	175	200	50	100	25	125	150	50
9																					
10	.02	.02	.03	.03	.16	.16	.16	.13	.13	.13	.03	.03	.03	.03	.03	.03	.10	.10	.10	.10	.10
11	.03	.03	.12	.12	.20	.20	.20	.20	.20	.20	.12	.12	.12	.12	.12	.12	.10	.10	.10	.10	.10
12	1.50	2.25	.88	1.25	.50	.75	.88	.63	1.00	1.13	.88	2.25	1.25	3.30	1.50	3.88	2.50	3.88	.88	2.50	3.88
13	.015	.025	.015	.015	.01	.01	.01	.01	.01	.01	.015	.034	.015	.034	.015	.034	.06	.06	.01	.06	.06
14	.012	.02	.012	.012	.008	.008	.008	.008	.008	.008	.012	.027	.012	.027	.012	.027	.048	.048	.008	.048	.048
15	1.30	1.69	.66	.936	.375	.56	.82	.47	.75	1.05	.66	1.69	.936	2.34	1.40	3.34	1.87	2.95	.66	1.87	2.85
16	.043	.043	.103	.103	.183	.183	.183	.153	.153	.153	.103	.103	.103	.103	.103	.103	.123	.123	.123	.123	.123
17																					
18	.01	.013	.013	.01	.01						.01	.024	.001	.024	.670	.024	.042	.042	.007	.042	.042
19	.93	1.44	.56								.56	1.13	.81	1.57	1.05	1.94	1.25	1.94	.56	1.25	1.94
20	.17	.17	.26	.26							.22	.22	.22	.22	.22	.22	.24	.24	.24	.24	.24
21	.073	.073	.163	.163							.163	.163	.163	.163	.163	.163	.143	.143	.143	.143	.143
22	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		5	5	5
23	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58	.58
24	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30
25	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43
26	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60
27	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	5.7	.57
28	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	4.0	.40
29	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.07	5.17	5.17	5.17	5.17	5.17	5.17
30	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27
31	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91	8.91
32	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63
33					2.25	3.13	3.88	3.25	3.13	3.88											
34					.06	.06	.06	.06	.06	.06											

Table 3.
Illustration 14, Page 1
(Form 7310-16)
(.33B)

7317 - EROSION

SEDIMENT YIELD FACTOR RATING

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

SEDIMENT YIELD FACTOR RATING

SURFACE GEOLOGY (a)	SOILS (b)	CLIMATE (c)	RUNOFF (d)	TOPOGRAPHY (e)
(10) a. Marine shales and related mudstones and siltstones	(10) a. Fine textured, easily dispersed; saline-alkaline; high shrink-swell characteristics b. Single grain silts and fine sands	(10) a. Storms of several days' duration with short periods of intense rainfall b. Frequent intense convective storms c. Freeze-thaw occurrence	(10) a. High peak flows per unit area b. Large volume of flow per unit area	(10) a. Steep upland slopes (in excess of 30%) b. High relief, little or no floodplain development
(5) a. Rocks of medium hardness b. Moderately weathered c. Moderately fractured	(5) a. Medium textured soil b. Occasional rock fragments c. Caliche layers	(5) a. Storms of moderate duration and intensity b. Infrequent convective storms	(5) a. Moderate peak flows per unit area b. Moderate volume of flow per unit area	(10) a. Moderate upland slopes (less than 30%) b. Moderate fan or floodplain development
(0) a. Massive, hard formations	(0) a. High percentage of rock fragments b. Aggregated clays c. High in organic matter	(0) a. Humid climate with rainfall of low intensity b. Precipitation in form of snow c. Arid climate, low intensity storms d. Arid climate; rare convective storms	(0) a. Low peak flows per unit area b. Low volume of runoff per unit area c. Rare runoff events	(0) a. Gentle upland slopes (less than 5%) b. Extensive alluvial plains
Factor value: 10	10	8	7	12

GROUND COVER (f)	LAND USE (g)	UPLAND EROSION (h)	CHANNEL EROSION AND SEDIMENT TRANSPORT (i)
(10) Ground cover does not exceed 20% a. Vegetation sparse; little or no litter b. No rock in surface soil	(10) a. More than 50% cultivated b. Almost all of area intensively grazed c. All of area recently burned	(25) a. More than 50% of the area characterized by rill and gully or landslide erosion	(25) a. Eroding banks continuously or at frequent intervals with large depths and long flow duration b. Active headcuts and degradation in tributary channels
(0) Cover not exceeding 40% a. Noticeable litter b. If trees present understory not well developed	(0) a. Less than 25% cultivated b. 50% or less recently logged c. Less than 50% intensively grazed d. Ordinary road and other construction	(10) a. About 25% of the area characterized by rill and gully or landslide erosion b. Wind erosion with deposition in stream channels	(10) a. Moderate flow depths, medium flow duration with occasionally eroding banks or bed
(-10) a. Area completely protected by vegetation, rock fragments, litter b. Little opportunity for rainfall to reach erodible material	(-10) a. No cultivation b. No recent logging c. Low intensity grazing	(0) a. No apparent signs of erosion	(0) a. Wide shallow channels with flat gradients and short flow duration b. Channels in massive rock, large boulders, or well vegetated c. Artificially controlled channels
Factor value: 10	10	25	8

Subtotal (a) - (g): 67 | Subtotal (h) - (i): 33 | TOTAL RATING: 100 = 3 Cubic yards per acre

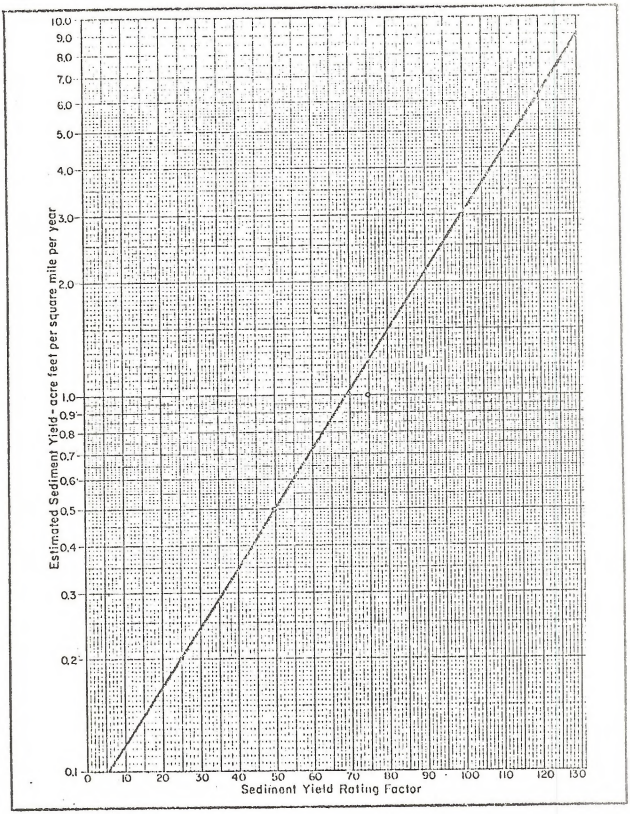
(Instructions on reverse)

Form 7310-16 (July 1971)

7317 - EROSION

FIGURE 3

SEDIMENT YIELD RATING FACTOR



the three allotments was available. This latter information was used to estimate upland erosion and channel erosion in Table 3. Tables 4 and 5 were used to estimate the impact of various treatments on sediment yield. For our examples, extensive treatment on Table 5 was considered to be grazing management alone, while intensive treatment was brush control, reseeding and grazing management.

3. The water run-off coefficient is in units of acre-feet and was not available from the URA. Estimates were calculated using BLM Manuals 7313 and 7315. The basic procedure was to derive a run-off curve number for each soil-vegetation type using Table 6 and then to find the direct run-off based on inches of rainfall using Figure 4. Rainfall and vegetation cover type were given in the URA overlays. Hydrologic soil group, hydrologic condition, and antecedent moisture condition were not specifically given in the URA, although procedures for finding this information is given in the indicated BLM manuals. For the purpose of the goal programming examples, soil and erosion information in the URA were used to estimate the hydrologic factors.
4. The wildlife and livestock diet coefficients were taken from BLM Manual Tech. Supplement 6601-6 for cattle, elk, and deer. Coefficient units were in AUMs of browse and AUMs of grass and forbs consumed in a particular season.
5. The forage production was divided by the AUMs/acre of browse plus AUMs/acre of grass and forbs for each response unit. The URA only provided the number of AUMs per grazing allotment. This value was averaged over the total acreage in the allotment to give a general estimate of AUMs/acre. The value was then adjusted for the various vegetative

TABLE 5

EVALUATION OF MEASURES

TABLE 5 - EVALUATION OF MEASURES

Sediment Yield Levels	Climatic Environment	F. GROUND COVER Extensive Treatment	F. GROUND COVER Intensive Treatment	G. LAND USE Extensive Treatment	G. LAND USE Intensive Treatment	H. UPLAND EROSION Extensive Treatment	H. UPLAND EROSION Intensive Treatment	I. CHANNEL EROSION & SEDIMENT TRANSPORT Extensive Treatment	I. CHANNEL EROSION & SEDIMENT TRANSPORT Intensive Treatment
High	Arid	8	5	8	5	20	15		
	Semi-arid	5	0	5	0	15	10		
	Sub-humid	0	-5	0	-5	10	5		
	Humid	-5	-10	-5	-10	5	0		
Moderate	Arid	0	-3	0	-3	10	7	20	5
	Semi-arid	-3	-5	-3	-5	7	5		
	Sub-humid	-5	-7	-5	-7	5	3		
	Humid	-7	-10	-7	-10	3	0		
								5	0

7315 - SURFACE-WATER HYDROLOGY

Rainfall-Runoff Curves

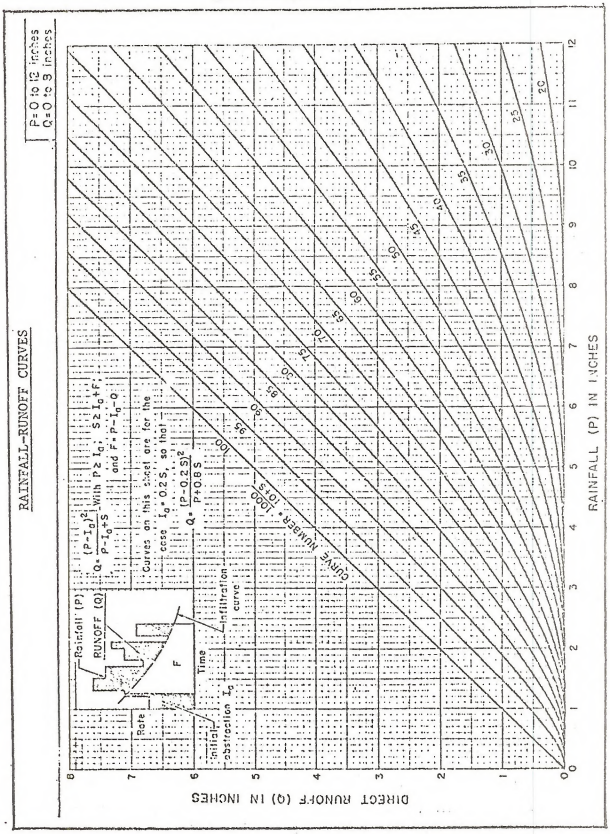


Illustration 7
(.43E2)

7313 - COVER

RUN-OFF CURVE NUMBERS FOR RANGE AREAS
(Antecedent Moisture Condition II and I_a = 0.2S)

Cover	Cover Treatment or Practice	Hydrologic Condition	Hydrologic Soil Group A	B	C	D
Grassland		Poor	66	79	86	89
		Fair	51	69	79	84
		Good	37	61	74	80
	Contoured	Poor	47	67	78	83
	"	Fair	38	61	74	80
	"	Good	28	55	70	77
Herbaceous		Poor	68	80	87	90
		Fair	55	71	81	85
		Good	42	63	74	81
Desert shrub		Poor	68	80	87	90
		Fair	52	70	80	85
		Good	39	62	75	80
Sagebrush		Poor	47	67	78	83
		Fair		48	65	74
		Good		30	53	64
Pinyon-juniper		Poor	60	75	83	87
		Fair	34	58	73	78
		Good		41	61	70
Chaparral (Arizona)		Poor	68	80	87	93
		Fair	32	57	71	83
		Good		41	58	74
Oak-aspen		Poor	43	64	76	82
		Fair		47	64	73
		Good		30	53	64
Ponderosa pine		Poor	45	66	77	83
		Fair	29	56	70	77
		Good		46	64	72
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77

Table 7.

4412 - INVENTORY RESOURCE STUDIES

FORAGE SURVEY TYPE WRITE UP
(WEIGHT ESTIMATE METHOD)

Illustration 6, Page 1
Form 4412-4
.11 Bb
.11 Bb-c(2) (c)
.11 Bab(4)
.11 Bab(4) (b)

FORAGE SURVEY TYPE WRITE UP
(WEIGHT ESTIMATE METHOD)

Write up No. 5-16 | Sheet No. | Date 6-15-66 | Aerial Photo No. 2-6-72

Examiner: A. O. Smith | KIND OF ANIMAL*: Cattle, Horses | SEASON OF USE: Sp-F, W | SECTIONS: 7, 8 & 18 | TWP.: 18S | RANGE: 34E | MER.: 2.4.4

Type: H-Ch-Int-Poor

PLOT RECORD OR SHEET SUMMARY OF GREEN WEIGHT

	SPECIES	1	2	3	4	5	6	7	8	9	10	TOTAL	LBS. GW/Ac	% DRY WT.	LBS. DW/Ac	PUF USE COMP. PLTS	PUF NON-COMP. GAME	LBS. UF/Ac USE COMP. PLTS	LBS. UF/Ac NON-COMP. GAME
GRASSES	Bouto	20	10	45	15	35	15	65	25	15	45	340	204	40	116	20	0	23	0
	Poa	10		20	20	15	5	10	20	10	30	140	140	60	84	25	0	21	0
	Cyper	1	35			5			45			81	81	30	41	45	0	12	0
	Elyus		10		1		5			5		21	21	45	9	15	0	1	0
	Salsy		5	5			10	20		10		50	20	45	23	35	0	3	0
FORBS	LUPI	5	1	15		5		35	10			71	71	35	25	20	0	5	0
	Unkw	1	10	5			10	10			15	51	51	30	15	10	0	0	0
	ERIGE	5		1	5				5	10		26	26	40	10	0	0	0	0
	Lupus	5	5		10	5			15	10		50	50	30	15	20	5	3	1
	SOPH		1			5	1		5	5	5	22	22	40	9	5	0	0	0
	HATE		5	10		10		5			10	40	40	40	16	5	0	1	0
SHRUBS	Ceno	25	35	60		40	45	15	35	30	20	305	305	30	151	5	—	4	—
	Cuch	5	5	5	15			10	10		20	70	70	30	21	30	10	6	2
	Pich		10			10		20	5			45	45	45	20	20	10	9	2
	Ceno	5			20							25	25	50	13	20	10	3	1
	Leat		5				10					15	15	45	7	40	5	3	0
TOTALS		81	137	166	86	130	101	210	190	115	145	1361	1361	(45)	607	(19)	(1)	117	6

Use Complex: 117 lbs. UF/Ac (tot.) × 85 % Utilizable = 99 lbs. UF/Ac (Net); 99 lbs./AUM (forage req.) = 4.4 lbs UF/Ac (Net) = 9.8 Ac/AUM

Noncompetitive Game: 6 lbs. UF/Ac (tot.) × 95 % Utilizable = 6 lbs. UF/Ac (Net); 9 lbs./AUM (forage req.) = .6 lbs UF/Ac (Net) = 15.0 Ac/AUM

Form 4412-4 (March 1955) (formerly 4-1276) USDI—BLM

* Livestock and major game species / other game species making inappreciable use are Cottontail

Illustration 1, Page 1
Form 4412-1
.11A3b
.11A3f(2)(c)
.11A4b(4)

Table 8.

4412 - PHYSICAL RESOURCE STUDIES

FORAGE SURVEY TYPE WRITE UP

(OCULAR RECONNAISSANCE METHOD)

Form 4412-1 (June 1964) (Formerly 4-1278)

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FORAGE SURVEY TYPE WRITE UP
(OCULAR RECONNAISSANCE METHOD)

Write up No. S 10
Date 6-15-66
Aerial Photo No. 30-12

Examiner	KIND OF GRAZING ANIMAL*	REASON OF USE	SECTIONS	TWP.	RGE.	MER.
A. B. Smith						
Type 4-Acre-Brit.-Pose	CAHle	Sp-F	1, 8, 4 18	17 S.	21 W	6th P.
AC/AUM 5.4	Deer	W				

	SPECIES	TOTAL ALLOWABLE PUF	% COMPOSITION	CATTLE PUF	COMP. X C PUF	SHEEP PUF	COMP. X S PUF	DEER PUF	COMP. X D PUF	PUF	COMP. X PUF
GRASSES	Brit	20	21	20	4.2			0	0		
	Pose	25	10	25	2.5			0	0		
	Oryz	45	6	40	2.4			5	.3		
	Alco	10	2	10	.2			0	0		
	Alky	35	4	35	1.4			0	0		
	SUBTOTAL		43								
FORBS	Aspe	20	5	15	.8			5	.3		
	Brea	40	4	35	1.4			5	.2		
	Lepe	0	2	0	0			0	0		
	Sahe	25	4	20	.8			5	.2		
	SOPH	5	2	5	.1			0	0		
	ARTE	5	3	5	.2			0	0		
	SUBTOTAL		20								
SHRUBS	Arti	70	26	5	1.3						
	Chri	40	5	25	1.3						
	Purs	60	3	45	1.4						
	Rhus	30	2	20	.4						
	Cost	45	1	30	.3						
	SUBTOTAL		37								
	TOTALS		100		18.4			6.8			

Av C PUF 18.4 × Av Den .85 = FAF 15.64 × .75 % Util = Net FAF 11.40 ; FAR .3 + Net FAF 11.40 = 37.2 Ac/AUM

Av S PUF ____ × Av Den ____ = FAF ____ × ____ % Util = Net FAF ____ ; FAR ____ + Net FAF ____ = ____ Ac/AUM

Av D PUF 6.8 × Av Den .35 = FAF 2.38 × .75 % Util = Net FAF 1.78 ; FAR .3 + Net FAF 1.78 = 17.8 Ac/AUM

Av PUF ____ × Av Den ____ = FAF ____ × ____ % Util = Net FAF ____ ; FAR ____ + Net FAF ____ = ____ Ac/AUM

Total Net FAF 13.18 ; FAR .3 + Net FAF 13.18 = 54.4 Ac/AUM

*Livestock and major game species. (Other game species making inappreciable use are Antelope

Illustration 9
Form 4412-20
(4412.13C)

Table 9.

4412 - PHYSICAL RESOURCE STUDIES

RANGE SUITABILITY SUMMARY

Form 4412-20
(January 1967)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

RANGE SUITABILITY SUMMARY

Planning Unit: Blue Creek

District: Carson City

Unit or Allotment: Alkali Wells

Date: 7-16-68

Acres	Federal Range	Private	State	Other (specify)
12,800	10,400	1,760	640	

Class of Livestock: Cow - calf

Season(s) of use: 5-15 to 10-15

CLASSIFICATION	ACRES	PERCENT
Suitable	10,446	82
Potentially suitable	2,048	16
Unsuitable	256	2

Remarks

Potentially suitable land is largely inaccessible "Mesa top." Although access by grazing animals is possible, accesssibility can be improved by trail construction through both pastures 1 and 4. Adequate water can be provided on the mesa by improvement in the spring in the NE¼ of Section 12. When better access and water are provided, this area can be integrated into the current deferred-rotation grazing system, decreasing livestock grazing load on the important wildlife habitat in pasture 3.

This improvement is programmed for FY 71

GPO 832 424

types within the allotment to provide an estimate of forage production for each response unit. BLM staff would not need to follow this procedure since BLM Forms 4412-1, 4412-4 and 4412-20 are prepared using BLM Manual 4412 (Forage Surveys)(Tables 7, 8 and 9). These forms provide all required information directly. The only calculation necessary is the conversion of acres/ 1 AUM (the units used in BLM forms) into AUM/acre.

6. The hunter-day coefficients were taken directly from the URA and included success ratio, harvest ratio of resident and non-resident hunters, hunter days per hunter, etc.
7. Coal production was estimated in tons per acre. The URA listed the average tons per acre of coal in the planning unit. Some surface disturbance does occur whether strip mining is used. We assumed surface disturbance would be equivalent for roads, machinery activity areas, etc.
8. Coefficients for the effect of various management practices on the production of flow resources were taken from the URA except for sediment. (Sedimentation values are discussed in item 2.)
9. The determination of the right-hand constraints and the ordering of goals will be discussed separately with the specific examples.

Although only a portion of the planning unit was used for demonstration of goal programming, the production and utilization coefficients for the entire North Fork Planning Unit were determined. These are presented in Appendix 6.

EXAMPLES OF GOAL PROGRAMMING

How much of what can be produced for whom is a basic resource management question that can be answered by goal programming. For example, a typical problem faced by a planning staff is the management of a multiple-use watershed area. In addition to the trade-offs between increasing water yield and the maintenance of sediment load at acceptable levels, the impact of watershed management practices on other uses such as wildlife, livestock production, and mining must be considered. To illustrate how goal programming can aid the management staff in such a problem, an actual watershed in the North Fork Planning Unit was used. Three grazing allotments, 28, 29 and 30 North, are BLM components of the Minnesota Creek Watershed east of Paonia, Colorado, and were chosen for several reasons. This area totals 9,909 acres with 1200 acres in Allotment 30N, 3595 in Allotment 29, and 5114 acres in Allotment 28. Each of these allotments was divided into "Homogeneous Response Units" and production and utilization coefficients determined (Table 2 and Figure 2).

The first column in Table 2 is labeled as 30N/1A. This label indicates "Homogeneous Response Unit" 1A in Allotment 30 North. The data in the column indicate that 1A is a sagebrush community on Brown Chestnut soil with 0 to 15 degrees of slope and a stable erosion class. Also given are the production coefficients for the various resource products under current management practices and how these coefficients would change under the various management alternatives such as grazing management and brush control. Since this response unit does not contain coal, there are no coefficients under the coal mining alternative.

The planning staff would have to set the level of production and utilization of the resource products which become the right-hand constraints

in the goal programming matrix. These values could be based on the current, actual level of use, or on a desired future use rate. In the following examples, cattle AUM usage rate was taken from the existing licensed rate and the number of deer and elk hunter days was based on the use in previous years. This information was taken from the URA. The deer and elk herd numbers were selected so that adequate herd sizes would exist to support hunting while maintaining a breeding herd of sufficient size. The water sediment yields were set at levels that would produce near maximum water yields with relatively low sediment content. See Table 10 for the desired production levels.

The next step after the desired production levels were established was to set priorities for production. These are the "goals" of goal programming. In the first example, goals have been selected to reflect the regional interests in the North Fork Planning Unit. These interests were determined by public inputs collected between July 24 and September 13, 1973. A summary of the public input occurs in Table 11. There was a total of 24 priorities and the first goal programming example's goals were established on the basis of seven of these. The seven priorities used in the example are marked with a single star. Production levels for water and sediment are the first two goals in accordance with priorities 2, 12, and 17. Cattle is the third goal based on priority 6 and the rate of cattle grazing on BLM lands is licensed at a fixed rate to the public. Deer and elk are the next two goals (4 and 5). The watershed is part of these animals' natural range and priority 8 reflects the public interest in wildlife. The next four goals are based on hunting management alternatives: six non-resident deer hunters, seven resident deer hunters, eight resident

Table 10. Resource production goals and optimum production levels under two watershed management priorities.

Production per allotment		Production goal	Optimum production water yield priority	Optimum production water quality priority
Water runoff	(30N)	40 acre feet	41.23 acre-feet	41.00 acre-feet
	(29)	50 " "	39.77 "	34.77 "
	(28)	300 " "	300.00 "	300.00 "
	Total	390 " "	381.00 "	375.80 "
Sediment	(30N)	800 tons	800 tons	800 tons
	(29)	2750 "	3318 "	2750 "
	(28)	6000 "	6774 "	6000 "
	Total	9550 "	10892 "	9550 "
Cattle	(30N)	330 cow unit months	131 cow unit months	221 cow unit months
	(29)	225 " " "	225 " " "	225 " " "
	(28)	575 " " "	116 " " "	575 " " "
	Total	1130 " " "	472 " " "	1011 " " "
Deer	(30N)	300 deer unit months	0 deer unit months	0 deer unit months
	(29)	800 " " "	933 " " "	933 " " "
	(28)	1200 " " "	0 " " "	390 " " "
	Total	2300 " " "	933 " " "	1323 " " "
Elk	(30N)	40 elk unit months	0 elk unit months	0 elk unit months
	(29)	108 " " "	108 " " "	108 " " "
	(28)	163 " " "	0 " " "	0 " " "
	Total	271 " " "	108 " " "	108 " " "
Non-resident deer hunter days	(30N)	720	0	0
	(29)	2090	2090	2090
	(28)	3480	0	0
	Total	6290	2090	2090
Resident deer hunter days	(30N)	324	0	0
	(29)	974	974	974
	(28)	1560	0	1560
	Total	2858	974	2534
Resident elk hunter days	(30N)	36	0	0
	(29)	108	108	108
	(28)	178	0	0
	Total	322	108	108
Non-resident elk hunter days	(30N)	41	0	0
	(29)	122	122	122
	(28)	196	0	0
	Total	359	122	122
Coal	(30N)	0 tons	0 tons	0 tons
	(29)	0 "	0 "	0 "
	(28)	20000000 "	20000000 "	20000000 "
	Total	20000000 "	20000000 "	20000000 "

Table 11.

Regional Input - North Fork Study Area

(99 persons/organizations individually invited. Ten persons representing six organizations attended, list attached)

Priority	(% Vote)	Item
#1	(56)	Prevent loss of remaining roadless areas.
#2	(45)	Maintenance of watersheds - keep water on Western Slope.
#3	(39)	Study area west of West Elk Mountains for possible addition to West Elk Wilderness Area.
#3	(39)	Maintain Ruby-Anthracite roadless area for possible future wilderness area - or maintain in present condition.
#4	(36)	Strict control of new subdivisions with regard to availability of water, sewage disposal, etc.
#5	(35)	Restrict off-road vehicles from areas where environmental damage may be caused.
#6	(31)	Avoid stripping of vegetation by overgrazing, clear cutting, etc.
#6	(31)	Emphasize cooperation between agencies.
#7	(28)	Consider environmental problems associated with growth and development.
#8	(24)	Develop strong tools to implement plans that evolve from this study.
#8	(24)	More consideration of wildlife values.
#9	(23)	Limit future mining (coal and other similar items) operations to underground
#10	(20)	Encourage multiple use of public land.
#11	(19)	Improve domestic water delivery systems, etc.
#12	(12)	Maintain minimum stream flows to enhance fish habitat.

Table 11. (Cont.)

Priority	(% Vote)	Item
#12	(12)	Maintain existing roads in the manner for which they were intended.
#13	(11)	Develop more diversified economic opportunities.
#13	(11)	Designate and publish hazard areas--i.e., landslide, flood plain, snow slide, etc.
#14	(9)	Establish tility corridors to carry pipelines, transmission lines, etc.
#15	(6)	Keep jeep trails as is--those that are established should be kept available.
#16	(5)	Develop ordinances to protect buyer of property.
#17	(4)	Increase agricultural water--particularly Fruitland Mesa.
#18	(2)	Improve transportation systems.
#19	(1)	Figure out hot to do these things and still stay out of court.

elk hunters, and nine non-resident elk hunters. The ordering of the goals reflected URA data on hunter numbers during previous years and the impact of hunting on the local economy. Coal is not now being produced in this watershed but since it is a potential use it was used as goal 10.

Two management alternatives for this watershed were analyzed to determine the trade-offs between water yield and sediment yield. In the first computer run, water yield was the first priority and sediment yield was the second priority. In the second computer run, these two priorities were reversed. The computer output for these two runs is presented in Appendix 1 (water yield, first priority) and Appendix 2 (water yield, second priority). A summary of how well each of the ten goals was achieved under these two different priorities is contained in Table 10.

The information for Table 10 was taken from Appendix 1 of the computer output under the sections "Goal Achievement" and "Goal Slack Analysis." In the "Goal Achievement" section, the goals not achieved are listed by how much the goal is under achieved. For example, in the run to maximize water yield the production goals were met in Allotment 28 and 30N but were short 10.22 acre-feet in Allotment 29 (Appendix 1). However, in Appendix 1 under "Goal Slack Analysis," it can be seen that 1.23 acre-feet of water was produced in Allotment 30N above the desired goal. Therefore, the water yield goal for the watershed was under achieved by 8.99 acre-feet. It should also be noted that of the ten goals only one was completely achieved in this run. That was coal production.

The computer output entitled "Optimal Value of Real Variables" lists the optimum level of production of the resource products and indicates

which management practices need to be applied to each acre of land to produce the optimum product yield for the given priorities and right-hand constraints. For example, Response Unit 1A in Allotment 30N should be managed as it currently is, while Response Unit 1C should receive brush control on 25 acres. The acres of land in the watershed to be placed under the various management alternatives are summarized for the two computer runs in Table 12.

Comparing the results of Tables 10 and 12, it can be seen that more of the goals are achieved when water quality rather than water yield is the first priority. However, information in Table 12 indicated that to achieve the optimum solution in the high water quality alternative land management must be much more intense. This not only means a greater expenditure of money, but also extensive brush control plus coal mining which would alter the appearance of much of the area and could result in a serious problem when one considers that three of the top four priorities from the public input reflect a desire to maintain large areas in their present state.

This example clearly presents a conflict between the people's desire to utilize natural resource products and their simultaneous desire to leave the land in an undeveloped condition. While goal programming does not solve this problem for the manager, it does inform him of areas where the conflict is greatest. For example, the difference between the two solutions for water yield varied by only 1.3 percent but the sediment load varied by 14 percent. So, the question becomes one of water quality and not quantity. The manager could then concentrate on determining the maximum sediment load that is acceptable for the intended use of the water. This value will determine how much of the watershed must be put under some form of intensive

Table 12. Required management practices to achieve optimum production under two watershed management priorities.

Management practice	Water yield priority acres to receive treatment	Water quality priority acres to receive treatment
No change	4796.42	2042.63
Brush control	400.45	2277.21
Grazing management	275.00	3730.02
Coal production	645.00	669.26
Available for deer winter range	3792.13	1191.09

management. This information provides the manager with qualitative data about trade-offs between water quality and the need for watershed treatment to help him make his final decision and to explain that decision to the public if necessary.

One possible solution to this conflict would be to eliminate the coal mining option. If the land were not disturbed by mining, there would be less erosion and higher water quality and more land would also be left in its present condition. Since coal production is not a high regional priority, this latter solution may be the best one. However, regional priorities may not be the same as national priorities.

Two currently high national priorities are red meat production and development of new energy sources. The North Fork Watershed offers both of these products. An examination of Table 10 reveals that the licensed cattle AUMs cannot be produced under the priorities used in these two options. To further understand the potential for cattle and coal production in light of regional priorities, three more goal programming solutions were obtained. In these solutions, cattle grazing was made the first goal and coal the second goal. Sediment yield was set as goal 3, deer and elk were goals 4 and 5, respectively, water yield was goal 6, and the four hunting alternatives were the last four goals. This ranking of goals remains the same in all three analyses. The level of cattle grazing in Allotment 28 changed for each of the three analyses.

In the first analysis the level of cattle grazing remained the same as in the two previous analyses. The desired production levels (right-hand constraints) for the other products also remained unchanged except for water yield and sediment yield. Both of these factors were set at very high levels

for the purpose of producing as much water as possible to develop coal and graze cattle. The sediment constraint was set at a high level so as not to limit coal production but the model was designed to minimize sediment as much as possible while still meeting the other goals. Table 13 contains the desired production levels.

The output for the first analysis is in Appendix 3. It can be observed that the production goals for cattle, deer, and elk were not achieved in Allotment 30N. Also, the results indicated that all of the flat and moderately-steep land in 30N must be placed under more intense management. By contrasts, Allotment 28's cattle, elk and deer goals were met as well as the goal for coal production. Furthermore, much of Allotment 28 was left in its present state of management (Figure 5).

The results also indicated that Allotment 30N was being overgrazed and that even under increased management this allotment cannot continue to support its licensed cattle AUMs and the local deer and elk herds without range deterioration. The URA analyses supported this conclusion. The AUMs of licensed use for 30N was 330 but the URA estimated forage production to suport only 159. This is a shortage of forage for 181 AUMs. The goal programming analysis estimated that this shortage could be reduced to 107 AUMs if the allotment were placed under a grazing management plan and brush control was applied in some areas. The URA applied numerical ratings to the present situation where a 0 (zero) indicated few if any management problems or conflicts and a 5 indi ated serious problems existed. Allotment 30N was rated by BLM as a 5 in both degree of overstocking and in wildlife conflict. The watershed was rated as 3. About 124 acres of the watershed are now classed as being in a moderate erosion condition

Table 13. Resource production goals and optimum production levels under three different levels of cattle AUM consumption.

Production per allotment		Production goal	Optimum production 585 cow unit months Allotment 28	Optimum production 685 cow unit months Allotment 28	Optimum production 985 cow unit months Allotment 28
Cattle	(30N)	330 cow unit months	223 cow unit months	223 cow unit months	223 cow unit months
	(29)	225 " " "	225 " " "	225 " " "	225 " " "
	(28)	585/635/985 " "	585 " " "	685 " " "	985 " " "
	Total	1140/1240/1540 " "	1033 " " "	1133 " " "	1433 " " "
Coal	(30N)	0 tons	0 tons	0 tons	0 tons
	(29)	0 "	0 "	0 "	0 "
	(28)	20,000,000 "	20,000,000 "	44,749,000 "	17,562,000 "
	Total	20,000,000 "	20,000,000 "	44,749,000 "	17,562,000 "
Sediment	(30N)	12,000 tons	842 tons	842 tons	842 tons
	(29)	12,000 "	3318 "	3318 "	3318 "
	(28)	12,000 "	6994 "	7477 "	5245 "
	Total	36,000 "	11154 "	11637 "	9405 "
Deer	(30N)	300 deer unit months	0 deer unit month	0 deer unit month	0 deer unit month
	(29)	800 " " "	933 " " "	933 " " "	933 " " "
	(28)	1200 " " "	1200 " " "	1200 " " "	0 " " "
	Total	2300 " " "	2133 " " "	2133 " " "	933 " " "
Elk	(30N)	40 elk unit months	0 elk unit month	0 elk unit month	0 elk unit month
	(29)	108 " " "	108 " " "	108 " " "	108 " " "
	(28)	163 " " "	163 " " "	163 " " "	0 " " "
	Total	311 " " "	271 " " "	271 " " "	108 " " "
Water runoff	(30N)	10,000 acre-feet	42 acre-feet	42 acre-feet	42 acre-feet
	(29)	10,000 " "	40 " "	40 " "	40 " "
	(28)	10,000 " "	303 " "	322 " "	220 " "
	Total	30,000 " "	385 " "	404 " "	302 " "
Resident elk hunter days	(30N)	36	0	0	0
	(29)	108	108	108	108
	(28)	178	178	178	0
	Total	322	286	286	108
Resident deer	(30N)	324	0	0	0
	(29)	974	974	974	974
	(28)	1560	1560	1560	0
	Total	2858	2534	2534	974
Non-resident deer hunter days	(30N)	720	0	0	0
	(29)	2090	2090	2090	2090
	(28)	3480	2455	2455	0
	Total	6290	4545	4545	2090
Non-resident elk hunter days	(30N)	41	0	0	0
	(29)	122	122	122	122
	(28)	196	196	196	0
	Total	359	318	318	122

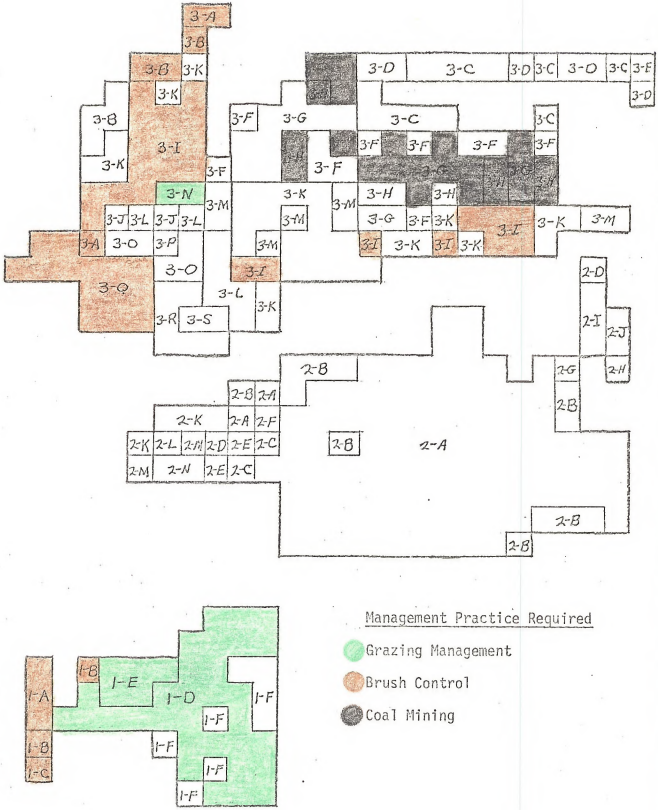


Figure 5. Location and type of management practices required to achieve optimum production with utilization of 585 cattle unit months in Allotment 28, with Allotments 29 and 30N remaining constant.

with another 250 acres expected to move into the moderate erosion condition in the future if current trends continue.

In contrast, the goal programming analysis indicated that Allotment 28 has potential for attaining higher levels of forage production if more comprehensive management is applied. The URA also supported this conclusion. The URA indicated that current range conditions are satisfactory and the trend is static. Wildlife conflict is high (rating of 5), but the degree of overstocking is rated as 1 with a watershed condition of 2.

Based on this analysis, another computer run was made to examine the possibility of increasing the licensed AUMs on Allotment 28 by 100 AUMs. This output is in Appendix 4. The analysis revealed that Allotment 28 could support an increase of 100 cattle AUMs in addition to the 585 now licensed. The deer and elk goal levels can also be met. In an attempt to achieve the water yield goal, the analyses indicated that more mountain shrub and aspen vegetation should be removed through coal mining. This resulted in doubling coal production to 40 million tons (Table 13).

An examination of Figure 6, the required management practices to achieve the optimum solution in the second analysis, revealed that any further increase in forage production can only occur if coal production is reduced. A series of computer runs was made in which the number of cattle AUMs required for Allotment 28 was increased by 25 AUMs in each run. The objective was to determine how high cattle production could go before the coal production goal could not be attained. This occurred when cattle AUMs reached 985. This result is in Appendix 5.

A summary of the three computer runs for the cattle-coal priorities is listed in Table 13. In summary, this series of analysis showed that

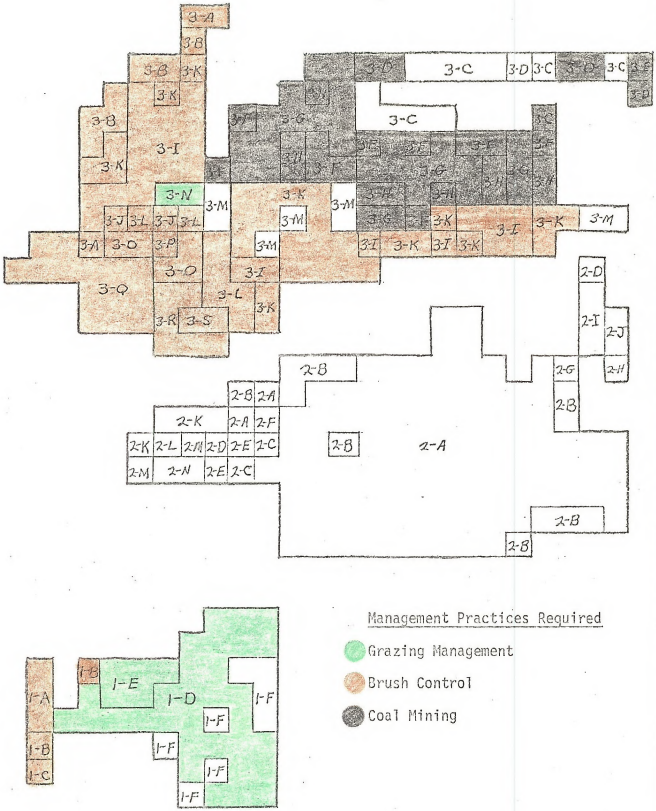


Figure 6. Location and type of management practices required to achieve optimum production with utilization of 685 cattle unit months in Allotment 28, with Allotments 29 and 30N remaining constant.

production of various resource products can be increased in this watershed if large-scale management is applied. However, Figures 5, 6 and 7 illustrated that the present ecosystem must be altered significantly which reflected our basic conflict between using the land and preserving it in its natural state. Goal programming can assist the manager in understanding the specific trade-offs of this type of conflict but the final decision must be made based on the judgement of the land manager.

In summary, how much of what can be produced for whom is a question that each BLM natural resource manager must answer. If a system for establishing priorities can be implemented for each resource use, then goal programming is probably the best available tool for assisting the manager in decision making with respect to the utilization of those resources.

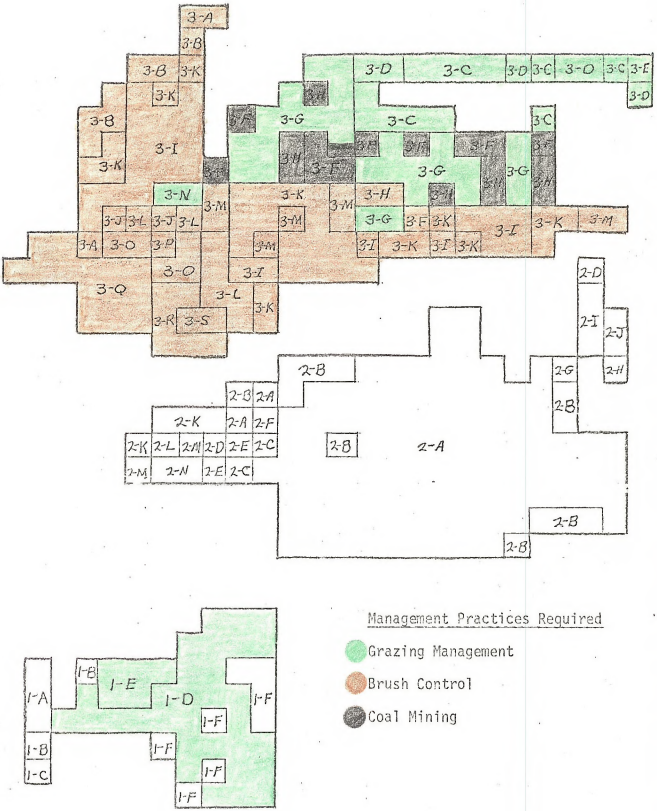


Figure 7. Location and type of management practices required to achieve optimum production with utilization of 985 cattle unit months in Allotment 28, with Allotments 29 and 30N remaining constant.

APPENDIX 1

CONSTRAINT SUMMARY

ROW NO.	ROW RIGHT-HAND-SIDE VALUE	ROW DESCRIPTION	ROW TYPE	NEGATIVE DEVIATIONS PRIORITY	NEGATIVE DEVIATIONS WEIGHT	POSITIVE DEVIATIONS PRIORITY	POSITIVE DEVIATIONS WEIGHT
R001	75.00	30N-1A	E	0	-0.00	0	-0.00
R002	50.00	30N-1B	E	0	-0.00	0	-0.00
R003	65.00	30N-1C	E	0	-0.00	0	-0.00
R004	725.00	30N-1D	E	0	-0.00	0	-0.00
R005	125.00	30N-1E	E	0	-0.00	0	-0.00
R006	200.00	30N-1F	E	0	-0.00	0	-0.00
R007	2700.00	29-2A	E	0	-0.00	0	-0.00
R008	300.00	29-2B	E	0	-0.00	0	-0.00
R009	50.00	29-2C	E	0	-0.00	0	-0.00
R010	50.00	29-2D	E	0	-0.00	0	-0.00
R011	50.00	29-2E	E	0	-0.00	0	-0.00
R012	25.00	29-2F	E	0	-0.00	0	-0.00
R013	25.00	29-2G	E	0	-0.00	0	-0.00
R014	25.00	29-2H	E	0	-0.00	0	-0.00
R015	75.00	29-2I	E	0	-0.00	0	-0.00
R016	50.00	29-2J	E	0	-0.00	0	-0.00
R017	100.00	29-2K	E	0	-0.00	0	-0.00
R018	25.00	29-2L	E	0	-0.00	0	-0.00
R019	50.00	29-2M	E	0	-0.00	0	-0.00
R020	50.00	29-2N	E	0	-0.00	0	-0.00
R021	75.00	28-3A	E	0	-0.00	0	-0.00
R022	175.00	28-3B	E	0	-0.00	0	-0.00
R023	300.00	28-3C	E	0	-0.00	0	-0.00
R024	150.00	28-3D	E	0	-0.00	0	-0.00
R025	25.00	28-3E	E	0	-0.00	0	-0.00
R026	300.00	28-3F	E	0	-0.00	0	-0.00
R027	750.00	28-3G	E	0	-0.00	0	-0.00
R028	250.00	28-3H	E	0	-0.00	0	-0.00
R029	750.00	28-3I	E	0	-0.00	0	-0.00
R030	50.00	28-3J	E	0	-0.00	0	-0.00
R031	950.00	28-3K	E	0	-0.00	0	-0.00
R032	175.00	28-3L	E	0	-0.00	0	-0.00
R033	200.00	28-3M	E	0	-0.00	0	-0.00
R034	50.00	28-3N	E	0	-0.00	0	-0.00
R035	150.00	28-3O	E	0	-0.00	0	-0.00
R036	25.00	28-3P	E	0	-0.00	0	-0.00
R037	425.00	28-3Q	E	0	-0.00	0	-0.00
R038	150.00	28-3R	E	0	-0.00	0	-0.00
R039	50.00	28-3S	E	0	-0.00	0	-0.00
R040	0.00	SCENIC VALUE 30N	G	0	-0.00	0	-0.00
R041	0.00	AUMS-GRASS FORBS 30N	G	0	-0.00	0	-0.00
R042	0.00	AUMS-BROWSE 30N	G	0	-0.00	0	-0.00
R043	0.00	RUNOFF-ACFT 30N	E	0	-0.00	0	-0.00
R044	0.00	SEDIMENT-TONS 30N	E	0	-0.00	0	-0.00
R045	0.00	SCENIC VALUE 29	G	0	-0.00	0	-0.00
R046	0.00	AUMS-GRASS FORBS 29	G	0	-0.00	0	-0.00
R047	0.00	AUMS-BROWSE 29	G	0	-0.00	0	-0.00
R048	0.00	RUNOFF-ACFT 29	E	0	-0.00	0	-0.00
R049	0.00	SEDIMENT-TONS 29	E	0	-0.00	0	-0.00
R050	0.00	SCENIC VALUE 28	G	0	-0.00	0	-0.00
R051	0.00	COAL-TONS (X1000) 28	E	0	-0.00	0	-0.00
R052	0.00	AUMS-GRASS FORBS 28	G	0	-0.00	0	-0.00
R053	0.00	AUMS-BROWSE 28	G	0	-0.00	0	-0.00
R054	0.00	RUNOFF-ACFT 28	E	0	-0.00	0	-0.00
R055	0.00	SEDIMENT-TONS 28	E	0	-0.00	0	-0.00
R056	300.00	DEER UNITS 30N	B	4	1.00	0	-0.00
R057	40.00	ELK UNITS 30N	B	5	1.00	0	-0.00
R058	330.00	COW-CALF UNITS 30N	B	3	1.00	0	-0.00
R059	800.00	SEDIMENT-TONS 30N	B	0	-0.00	2	1.00
R060	40.00	RUNOFF-ACFT 30N	B	1	1.00	0	-0.00
R061	324.00	RES DEER HUNTERS 30N	B	7	1.00	0	-0.00
R062	36.00	RES ELK HUNTERS	B	8	1.00	0	-0.00
R063	720.00	NRES DEER HUNTER 30N	B	6	1.00	0	-0.00
R064	41.00	NRES ELK HUNTERS 30N	B	9	1.00	0	-0.00
R065	800.00	DEER UNITS 29	B	4	1.00	0	-0.00
R066	108.00	ELK UNITS 29	B	5	1.00	0	-0.00
R067	225.00	COW-CALF UNITS 29	B	3	1.00	0	-0.00
R068	2750.00	SEDIMENTS-TONS 29	B	0	-0.00	2	1.00
R069	50.00	RUNOFF-ACFT 29	B	1	1.00	0	-0.00
R070	974.00	RES DEER HUNTERS 29	B	7	1.00	0	-0.00
R071	108.00	RES ELK HUNTERS 29	B	8	1.00	0	-0.00
R072	2090.00	NRES DEER HUNTERS 29	B	6	1.00	0	-0.00
R073	142.00	NRES ELK HUNTERS 29	B	9	1.00	0	-0.00
R074	1200.00	DEER UNITS 28	B	4	1.00	0	-0.00
R075	163.00	ELK UNITS 28	B	5	1.00	0	-0.00
R076	575.00	COW-CALF UNITS 28	B	3	1.00	0	-0.00
R077	20000.00	COAL-TONS (X1000) 28	B	10	1.00	0	-0.00
R078	6000.00	SEDIMENT-TONS 28	B	0	-0.00	2	1.00
R079	300.00	RUNOFF-ACFT 28	B	1	1.00	0	-0.00
R080	1566.00	RES DEER HUNTERS 28	B	7	1.00	0	-0.00
R081	170.00	RES ELK HUNTERS 28	B	8	1.00	0	-0.00
R082	3480.00	NRES DEER HUNTERS 28	B	6	1.00	0	-0.00
R083	196.00	NRES ELK HUNTERS 28	B	9	1.00	0	-0.00
R084	0.00	DEER UNITS 30N	G	0	-0.00	0	-0.00
R085	0.00	DEER UNITS 29	G	0	-0.00	0	-0.00
R086	0.00	DEER UNITS 28	G	0	-0.00	0	-0.00
R087	0.00	ELK UNITS 30N	G	0	-0.00	0	-0.00
R088	0.00	ELK UNITS 29	G	0	-0.00	0	-0.00
R089	0.00	ELK UNITS 28	G	0	-0.00	0	-0.00

OPTIMAL VALUE OF REAL VARIABLES

VARIABLE	DESCRIPTION	AMOUNT
X001	30N-1A NO CHANGE	75.00
X005	30N-1B NO CHANGE	50.00
X012	30N-1C BRUSH CONTROL	25.00
X013	30N-1D NO CHANGE	485.33
X017	30N-1E NO CHANGE	125.00
X020	30N-1F NO CHANGE	200.00
X024	29-2A NO CHANGE	2700.00
X028	29-2B NO CHANGE	266.71
X029	29-2H DEER WINTER	33.49
X032	29-2C NO CHANGE	50.00
X034	29-2D NO CHANGE	50.00
X037	29-2E NO CHANGE	50.00
X042	29-2F NO CHANGE	25.00
X045	29-2G NO CHANGE	25.00
X050	29-2H NO CHANGE	25.00
X055	29-2I NO CHANGE	75.00
X060	29-2J NO CHANGE	50.00
X063	29-2K NO CHANGE	100.00
X065	29-2L NO CHANGE	25.00
X067	29-2M NO CHANGE	50.00
X070	29-2N NO CHANGE	50.00
X074	28-3A GRAZING MGT	75.00
X077	28-3B GRAZING MGT	175.00
X081	28-3C DEER WINTER	300.00
X084	28-3D COAL DEVELOP	150.00
X088	28-3E GRAZING MGT	25.00
X090	28-3F COAL DEVELOP	300.00
X094	28-3G COAL DEVELOP	195.16
X095	28-3G DEER WINTER	554.84
X099	28-3H DEER WINTER	250.00
X102	28-3I DEER WINTER	750.00
X107	28-3J BRUSH CONTROL	50.00
X109	28-3K DEER WINTER	950.00
X115	28-3L BRUSH CONTROL	175.00
X117	28-3M DEER WINTER	200.00
X123	28-3N BRUSH CONTROL	50.00
X125	28-3O DEER WINTER	124.55
X127	28-3O BRUSH CONTROL	25.45
X131	28-3P BRUSH CONTROL	25.00
X133	28-3Q DEER WINTER	425.00
X137	28-3P DEER WINTER	150.00
X143	28-3S BRUSH CONTROL	50.00
X146	30N COW-CALF AUMS	131.56
X147	30N SEDIMENT-TONS	800.00
X148	30N RUNOFF-ACFT	41.23
X150	30N RES ELK HUNTER	0.00
X151	30N RES DEER HUNTER	0.00
X153	29 DEER UNITS	933.20
X154	29 ELK UNITS	108.00
X155	29 COW-CALF AUMS	225.00
X156	29 SEDIMENT-TONS	3317.75
X157	29 RUNOFF-ACFT	39.77
X158	29 RES DEER HUNTER	974.00
X159	29 RES ELK HUNTER	108.00
X160	29 RES DEER HUNTER	2090.00
X161	29 RES ELK HUNTER	122.00
X164	28 COW-CALF UNITS	116.09
X165	28 COAL-TONS	20000.00
X166	28 SEDIMENT-TONS	6774.43
X167	28 RUNOFF-ACFT	300.00
X168	28 RES DEER HUNTER	0.00

GOAL ACHIEVEMENT

```
GOAL LEVEL      1 IS NOT ACHIEVEO IN THE FOLLOWING CONSTRAINTS:
        *       R069, RUNOFF-ACFT 29        ,
                IS UNDERACHIEVED BY          10.22 UNITS.
        * SUMMARY:
          GOAL      1 IS NOT ACHIEVED BY          10.22 WGTD UNITS.

GOAL LEVEL      2 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *       R068, SEDIMENTS-TONS 29     ,
                IS OVERACHIEVEO  BY         567.75 UNITS.
        *       R078, SEDIMENT-TONS 28      ,
                IS OVERACHIEVEO  BY         774.43 UNITS.
        * SUMMARY:
          GOAL      2 IS NOT ACHIEVEO BY        1342.18 WGTO UNITS.

GOAL LEVEL      3 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *       R058, COW-CALF UNITS 30N    ,
                IS UNDERACHIEVED BY         198.44 UNITS.
        *       R076, COW-CALF UNITS 28     ,
                IS UNDERACHIEVEO BY         458.91 UNITS.
        * SUMMARY:
          GOAL      3 IS NOT ACHIEVED BY         657.34 WGTD UNITS.

GOAL LEVEL      4 IS NOT ACHIEVEO IN THE FOLLOWING CONSTRAINTS:
        *       R056, DEER UNITS 30N        ,
                IS UNOERACHIEVED BY         300.00 UNITS.
        *       R074, DEER UNITS 28         ,
                IS UNOERACHIEVED BY        1200.00 UNITS.
        * SUMMARY:
          GOAL      4 IS NOT ACHIEVEO BY        1500.00 WGTO UNITS.

GOAL LEVEL      5 IS NOT ACHIEVEO IN THE FOLLOWING CONSTRAINTS:
        *       R057, ELK UNITS 30N         ,
                IS UNOERACHIEVED BY          40.00 UNITS.
        *       R075, ELK UNITS 28          ,
                IS UNOERACHIEVED BY         163.00 UNITS.
        * SUMMARY:
          GOAL      5 IS NOT ACHIEVEO BY         203.00 WGTD UNITS.

GOAL LEVEL      6 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *       R063, NRES OEER HUNTER 30N,
                IS UNDERACHIEVED BY         720.00 UNITS.
        *       R082, NRES OEER HUNTERS 28,
                IS UNOERACHIEVEO BY        3480.00 UNITS.
        * SUMMARY:
          GOAL      6 IS NOT ACHIEVEO BY        4200.00 WGTO UNITS.

GOAL LEVEL      7 IS NOT ACHIEVEO IN THE FOLLOWING CONSTRAINTS:
        *       R061, RES DEER HUNTERS 30N,
                IS UNOERACHIEVEO BY         324.00 UNITS.
        *       R080, RES DEER HUNTERS 28 ,
                IS UNDERACHIEVEO BY        1560.00 UNITS.
        * SUMMARY:
          GOAL      7 IS NOT ACHIEVEU BY        1884.00 WGTD UNITS.

GOAL LEVEL      8 IS NOT ACHIEVEO IN THE FOLLOWING CONSTRAINTS:
        *       R062, RES ELK HUNTERS       ,
                IS UNDERACHIEVEO BY          36.00 UNITS.
        *       R081, RES ELK HUNTERS 28    ,
                IS UNDERACHIEVEO BY         178.00 UNITS.
        * SUMMARY:
          GOAL      8 IS NOT ACHIEVED BY         214.00 WGTO UNITS.

GOAL LEVEL      9 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *       R064, NRES ELK HUNTERS 30N,
                IS UNDERACHIEVED BY          41.00 UNITS.
        *       R083, NRES ELK HUNTERS 28 ,
                IS UNDERACHIEVED BY         196.00 UNITS.
        * SUMMARY:
          GOAL      9 IS NOT ACHIEVED BY         237.00 WGTO UNITS.

GOAL LEVEL     10 IS*****************************COMPLETELY ACHIEVED.
```

GOAL SLACK ANALYSIS

THIS SECTION ANALYZES GOAL CONSTRAINTS WITH -B- TYPE INEQUALITIES WHERE EITHER A NEGATIVE OR POSITIVE DEVIATION IS NOT GIVEN A PRIORITY LEVEL. THE INDICATED WILL THEN REFLECT THE AMOUNT BY WHICH THE EXACT GOAL WAS NOT ACHIEVED, EVEN-THOUGH THE MINIMUM OR MAXIMUM GOAL LEVEL WAS ACHIEVED.

ROW NUMBER	GOAL DESCRIPTION	EXACT GOAL LEVEL	NEGATIVE SLACK	POSITIVE SLACK
R060	RUNOFF-ACFT 30N	40.00	0000.00	1.23
R065	DEER UNITS 29	800.00	0000.00	133.20

RESOURCE UTILIZATION ANALYSIS

ROW NUMBER	RESOURCE DESCRIPTION	EXACT RESOURCE LEVEL	RESOURCE NOT-USED	RESOURCE OVER-PRODUCED
R040	SCENIC VALUE 30N	0.00	0000.00	2195.67
R042	AUMS-BROWSE 30N	0.00	0000.00	94.77
R045	SCENIC VALUE 29	0.00	0000.00	7725.00
R046	AUMS-GRASS FORBS 29	0.00	0000.00	118.32
R047	AUMS-BROWSE 29	0.00	0000.00	472.28
R050	SCENIC VALUE 28	0.00	0000.00	5103.05
R053	AUMS-BROWSE 28	0.00	0000.00	611.05
R068	ELK UNITS 29	0.00	0000.00	73.92
R069	ELK UNITS 28	0.00	0000.00	0.00

APPENDIX 2

CONSTRAINT SUMMARY

ROW NO.	ROW RIGHT-HAND-SIDE VALUE	ROW DESCRIPTION	ROW TYPE	NEGATIVE DEVIATIONS PRIORITY	NEGATIVE DEVIATIONS WEIGHT	POSITIVE DEVIATIONS PRIORITY	POSITIVE DEVIATIONS WEIGHT
R001	75.00	30N-1A	E	0	-0.00	0	-0.00
R002	50.00	30N-1B	E	0	-0.00	0	-0.00
R003	25.00	30N-1C	E	0	-0.00	0	-0.00
R004	725.00	30N-1D	E	0	-0.00	0	-0.00
R005	125.00	30N-1E	E	0	-0.00	0	-0.00
R006	200.00	30N-1F	E	0	-0.00	0	-0.00
R007	2700.00	29-2A	E	0	-0.00	0	-0.00
R008	800.00	29-2B	E	0	-0.00	0	-0.00
R009	50.00	29-2C	E	0	-0.00	0	-0.00
R010	50.00	29-2D	E	0	-0.00	0	-0.00
R011	50.00	29-2E	E	0	-0.00	0	-0.00
R012	25.00	29-2F	E	0	-0.00	0	-0.00
R013	25.00	29-2G	E	0	-0.00	0	-0.00
R014	25.00	29-2H	E	0	-0.00	0	-0.00
R015	75.00	29-2I	E	0	-0.00	0	-0.00
R016	50.00	29-2J	E	0	-0.00	0	-0.00
R017	100.00	29-2K	E	0	-0.00	0	-0.00
R018	25.00	29-2L	E	0	-0.00	0	-0.00
R019	50.00	29-2M	E	0	-0.00	0	-0.00
R020	50.00	29-2N	E	0	-0.00	0	-0.00
R021	75.00	28-3A	E	0	-0.00	0	-0.00
R022	175.00	28-3B	E	0	-0.00	0	-0.00
R023	300.00	28-3C	E	0	-0.00	0	-0.00
R024	150.00	28-3D	E	0	-0.00	0	-0.00
R025	25.00	28-3E	E	0	-0.00	0	-0.00
R026	300.00	28-3F	E	0	-0.00	0	-0.00
R027	750.00	28-3G	E	0	-0.00	0	-0.00
R028	250.00	28-3H	E	0	-0.00	0	-0.00
R029	750.00	28-3I	E	0	-0.00	0	-0.00
R030	50.00	28-3J	E	0	-0.00	0	-0.00
R031	950.00	28-3K	E	0	-0.00	0	-0.00
R032	175.00	28-3L	E	0	-0.00	0	-0.00
R033	200.00	28-3M	E	0	-0.00	0	-0.00
R034	50.00	28-3N	E	0	-0.00	0	-0.00
R035	150.00	28-3O	E	0	-0.00	0	-0.00
R036	25.00	28-3P	E	0	-0.00	0	-0.00
R037	425.00	28-3Q	E	0	-0.00	0	-0.00
R038	150.00	28-3R	E	0	-0.00	0	-0.00
R039	50.00	28-3S	E	0	-0.00	0	-0.00
R040	0.00	SCENIC VALUE 30N	G	0	-0.00	0	-0.00
R041	0.00	AUMS-GRASS FORBS 30N	G	0	-0.00	0	-0.00
R042	0.00	AUMS-BROWSE 30N	G	0	-0.00	0	-0.00
R043	0.00	RUNOFF-ACFT 30N	E	0	-0.00	0	-0.00
R044	0.00	SEDIMENT-TONS 30N	E	0	-0.00	0	-0.00
R045	0.00	SCENIC VALUE 29	G	0	-0.00	0	-0.00
R046	0.00	AUMS-GRASS FORBS 29	G	0	-0.00	0	-0.00
R047	0.00	AUMS-BROWSE 29	G	0	-0.00	0	-0.00
R048	0.00	RUNOFF-ACFT 29	E	0	-0.00	0	-0.00
R049	0.00	SEDIMENT-TONS 29	E	0	-0.00	0	-0.00
R050	0.00	SCENIC VALUE 28	G	0	-0.00	0	-0.00
R051	0.00	COAL-TONS (X1000) 28	E	0	-0.00	0	-0.00
R052	0.00	AUMS-GRASS FORBS 28	G	0	-0.00	0	-0.00
R053	0.00	AUMS-BROWSE 28	G	0	-0.00	0	-0.00
R054	0.00	RUNOFF-ACFT 28	E	0	-0.00	0	-0.00
R055	0.00	SEDIMENT-TONS 28	E	0	-0.00	0	-0.00
R056	300.00	DEER UNITS 30N	B	4	1.00	0	-0.00
R057	50.00	ELK UNITS 30N	B	5	1.00	0	-0.00
R058	330.00	COW-CALF UNITS 30N	B	3	1.00	0	-0.00
R059	800.00	SEDIMENT-TONS 30N	B	0	-0.00	1	1.00
R060	50.00	RUNOFF-ACFT 30N	B	2	1.00	0	-0.00
R061	324.00	RES DEER HUNTERS 30N	B	7	1.00	0	-0.00
R062	36.00	RES ELK HUNTERS	B	8	1.00	0	-0.00
R063	720.00	NRES DEER HUNTRS 30N	B	6	1.00	0	-0.00
R064	41.00	NRES ELK HUNTERS 30N	B	9	1.00	0	-0.00
R065	800.00	DEER UNITS 29	B	4	1.00	0	-0.00
R066	108.00	ELK UNITS 29	B	5	1.00	0	-0.00
R067	225.00	COW-CALF UNITS 29	B	3	1.00	0	-0.00
R068	2750.00	SEDIMENTS-TONS 29	B	0	-0.00	1	1.00
R069	50.00	RUNOFF-ACFT 29	B	2	1.00	0	-0.00
R070	974.00	RES DEER HUNTERS 29	B	7	1.00	0	-0.00
R071	108.00	RES ELK HUNTERS 29	B	8	1.00	0	-0.00
R072	2090.00	NRES DEER HUNTRS 29	B	6	1.00	0	-0.00
R073	122.00	NRES ELK HUNTERS 29	B	9	1.00	0	-0.00
R074	1200.00	DEER UNITS 28	B	4	1.00	0	-0.00
R075	163.00	ELK UNITS 28	B	5	1.00	0	-0.00
R076	575.00	COW-CALF UNITS 28	B	3	1.00	0	-0.00
R077	20000.00	COAL-TONS (X1000) 28	B	10	1.00	0	-0.00
R078	6000.00	SEDIMENT-TONS 28	B	0	-0.00	1	1.00
R079	300.00	RUNOFF-ACFT 28	B	2	1.00	0	-0.00
R080	1500.00	RES DEER HUNTERS 28	B	7	1.00	0	-0.00
R081	170.00	RES ELK HUNTERS 28	B	8	1.00	0	-0.00
R082	3400.00	NRES DEER HUNTRS 28	B	6	1.00	0	-0.00
R083	190.00	NRES ELK HUNTERS 28	B	9	1.00	0	-0.00
R084	0.00	DEER UNITS 30N	G	0	-0.00	0	-0.00
R085	0.00	DEER UNITS 29	G	0	-0.00	0	-0.00
R086	0.00	DEER UNITS 28	G	0	-0.00	0	-0.00
R087	0.00	ELK UNITS 30N	G	0	-0.00	0	-0.00
R088	0.00	ELK UNITS 29	G	0	-0.00	0	-0.00
R089	0.00	ELK UNITS 28	G	0	-0.00	0	-0.00

OPTIMAL VALUE OF REAL VARIABLES

VARIABLE	DESCRIPTION	AMOUNT
X004	30N-1A BRUSH CONTROL	75.00
X008	30N-1B BRUSH CONTROL	50.00
X012	30N-1C BRUSH CONTROL	25.00
X016	30N-1D GRAZING MGT	725.00
X019	30N-1E GRAZING MGT	125.00
X020	30N-1F NO CHANGE	47.79
X023	30N-1G GRAZING MGT	152.21
X024	29-2A NO CHANGE	1511.84
X027	29-2B GRAZING MGT	1088.16
X031	29-2D GRAZING MGT	300.00
X033	29-2C GRAZING MGT	50.00
X036	29-2D BRUSH CONTROL	50.00
X037	29-2E NO CHANGE	50.00
X044	29-2F BRUSH CONTROL	25.00
X049	29-2G BRUSH CONTROL	25.00
X053	29-2H GRAZING MGT	25.00
X059	29-2I BRUSH CONTROL	75.00
X062	29-2J BRUSH CONTROL	50.00
X064	29-2K GRAZING MGT	100.00
X066	29-2L GRAZING MGT	25.00
X069	29-2M BRUSH CONTROL	50.00
X072	29-2N BRUSH CONTROL	50.00
X074	28-3A GRAZING MGT	75.00
X078	28-3B BRUSH CONTROL	175.00
X080	28-3C COAL DEVELOP	300.00
X085	28-3D GRAZING MGT	150.00
X088	28-2E GRAZING MGT	25.00
X090	28-3F COAL DEVELOP	300.00
X094	28-3G COAL DEVELOP	89.26
X096	28-3G GRAZING MGT	680.74
X099	28-3H DEER WINTER	250.00
X104	28-3I BRUSH CONTROL	750.00
X107	28-3J BRUSH CONTROL	50.00
X109	28-3K DEER WINTER	741.09
X110	28-3K GRAZING MGT	208.91
X115	28-3L BRUSH CONTROL	175.00
X117	28-3M DEER WINTER	200.00
X123	28-3N BRUSH CONTROL	50.00
X124	28-3O NO CHANGE	150.00
X131	28-3P BRUSH CONTROL	25.00
X135	28-3Q BRUSH CONTROL	425.00
X136	28-3R NO CHANGE	150.00
X143	28-3S BRUSH CONTROL	50.00
X146	30N COW-CALF AUMS	221.04
X147	30N SEDIMENT-TONS	800.00
X148	30N RUNOFF-ACFT	41.02
X150	30N RES ELK HUNTER	0.00
X151	30N NRES DEER HUNTER	0.00
X153	29 DEER UNITS	933.20
X154	29 ELK UNITS	108.00
X155	29 COW-CALF AUMS	225.00
X156	29 SEDIMENT-TONS	2750.00
X157	29 RUNOFF-ACFT	34.77
X158	29 RES DEER HUNTER	974.00
X159	29 RES ELK HUNTER	108.00
X160	29 NRES DEER HUNTER	2090.00
X161	29 NRES ELK HUNTER	122.00
X162	28 DEER UNITS	390.00
X164	28 COW-CALF UNITS	575.00
X165	28 COAL-TONS	20747.19
X166	28 SEDIMENT-TONS	6000.00
X167	28 RUNOFF-ACFT	300.00
X168	28 RES DEER HUNTER	1560.00

GOAL ACHIEVEMENT

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GOAL LEVEL      1 IS*****************************COMPLETELY ACHIEVED.

GOAL LEVEL      2 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *       R069. RUNOFF-ACFT 29        ,
                IS UNDERACHIEVED BY          15.23 UNITS.
        * SUMMARY:
          GOAL      2 IS NOT ACHIEVED BY          15.23 WGTD UNITS.

GOAL LEVEL      3 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *       R058. COW-CALF UNITS 30N    ,
                IS UNDERACHIEVED BY         108.96 UNITS.
        * SUMMARY:
          GOAL      3 IS NOT ACHIEVED BY         108.96 WGTD UNITS.

GOAL LEVEL      4 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *       R056. DEER UNITS 30N        ,
                IS UNDERACHIEVED BY         300.00 UNITS.
        *       R074. DEER UNITS 28         ,
                IS UNDERACHIEVED BY         810.00 UNITS.
        * SUMMARY:
          GOAL      4 IS NOT ACHIEVED BY        1110.00 WGTD UNITS.

GOAL LEVEL      5 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *       R057. ELK UNITS 30N         ,
                IS UNDERACHIEVED BY          40.00 UNITS.
        *       R075. ELK UNITS 28          ,
                IS UNDERACHIEVED BY         163.00 UNITS.
        * SUMMARY:
          GOAL      5 IS NOT ACHIEVED BY         203.00 WGTD UNITS.

GOAL LEVEL      6 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *       R063. NRES DEER HUNTER 30N,
                IS UNDERACHIEVED BY         720.00 UNITS.
        *       R082. NRES DEER HUNTERS 28,
                IS UNDERACHIEVED BY        3480.00 UNITS.
        * SUMMARY:
          GOAL      6 IS NOT ACHIEVED BY        4200.00 WGTD UNITS.

GOAL LEVEL      7 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *       R061. RES DEER HUNTERS 30N,
                IS UNDERACHIEVED BY         324.00 UNITS.
        * SUMMARY:
          GOAL      7 IS NOT ACHIEVED BY         324.00 WGTD UNITS.

GOAL LEVEL      8 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *       R062. RES ELK HUNTERS       ,
                IS UNDERACHIEVED BY          36.00 UNITS.
        *       R081. RES ELK HUNTERS 28    ,
                IS UNDERACHIEVED BY         178.00 UNITS.
        * SUMMARY:
          GOAL      8 IS NOT ACHIEVED BY         214.00 WGTD UNITS.

GOAL LEVEL      9 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *       R064. NRES ELK HUNTERS 30N,
                IS UNDERACHIEVED BY          41.00 UNITS.
        *       R083. NRES ELK HUNTERS 28   ,
                IS UNDERACHIEVED BY         196.00 UNITS.
        * SUMMARY:
          GOAL      9 IS NOT ACHIEVED BY         237.00 WGTD UNITS.

GOAL LEVEL     10 IS*****************************COMPLETELY ACHIEVED.
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GOAL SLACK ANALYSIS

THIS SECTION ANALYZES GOAL CONSTRAINTS WITH -B- TYPE INEQUALITIES WHERE EITHER A NEGATIVE OR POSITIVE DEVIATION IS NOT GIVEN A PRIORITY LEVEL. THE INDICATED WILL THEN REFLECT THE AMOUNT BY WHICH THE EXACT GOAL WAS NOT ACHIEVED; EVEN-THOUGH THE MINIMUM OR MAXIMUM GOAL LEVEL WAS ACHIEVED.

ROW NUMBER	GOAL DESCRIPTION	EXACT GOAL LEVEL	NEGATIVE SLACK	POSITIVE SLACK
R060	RUNOFF-ACFT 30N	40.00	0000.00	1.02
R065	DEER UNITS 29	800.00	0000.00	133.20
R077	COAL-TONS (X1000) 28	20000.00	0000.00	747.19

RESOURCE UTILIZATION ANALYSIS

ROW NUMBER	RESOURCE DESCRIPTION	EXACT RESOURCE LEVEL	RESOURCE NOT-USED	RESOURCE OVER-PRODUCED
R040	SCENIC VALUE 30N	0.00	0000.00	2850.00
R042	AUMS-BROWSE 30N	0.00	0000.00	125.29
R045	SCENIC VALUE 29	0.00	0000.00	8225.00
R046	AUMS-GRASS FORBS 29	0.00	0000.00	205.24
R047	AUMS-BROWSE 29	0.00	0000.00	492.91
R050	SCENIC VALUE 28	0.00	0000.00	13046.32
R052	AUMS-GRASS FORBS 28	0.00	0000.00	7.81
R053	AUMS-BROWSE 28	0.00	0000.00	590.86
R066	ELK UNITS 29	0.00	0000.00	73.92
R069	ELK UNITS 28	0.00	0000.00	0.00

APPENDIX 3

CONSTRAINT SUMMARY

ROW NO.	ROW RIGHT-HAND-SIDE VALUE	FOR DESCRIPTION	ROW TYPE	NEGATIVE DEVIATIONS PRIORITY	NEGATIVE DEVIATIONS WEIGHT	POSITIVE DEVIATIONS PRIORITY	POSITIVE DEVIATIONS WEIGHT
R001	75.00	3R-14	E	0	+0.00	0	+0.00
R002	30.00	3R-1B	E	0	+0.00	0	+0.00
R003	45.00	3R-1C	E	0	+0.00	0	+0.00
R004	750.00	3R-1D	E	0	+0.00	0	+0.00
R005	125.00	3R-1E	E	0	+0.00	0	+0.00
R006	225.00	3R-1F	E	0	+0.00	0	+0.00
R007	2700.00	2R-20	E	0	+0.00	0	+0.00
R008	400.00	2R-21	E	0	+0.00	0	+0.00
R009	30.00	2R-22	E	0	+0.00	0	+0.00
R010	30.00	2R-23	E	0	+0.00	0	+0.00
R011	20.00	2R-2[illegible]	E	0	+0.00	0	+0.00
R012	25.00	2R-2[illegible]	E	0	+0.00	0	+0.00
R013	25.00	2R-23	E	0	+0.00	0	+0.00
R014	25.00	2R-24	E	0	+0.00	0	+0.00
R015	75.00	2R-2[illegible]	E	0	+0.00	0	+0.00
R016	30.00	2R-2[illegible]	E	0	+0.00	0	+0.00
R017	100.00	2R-2B	E	0	+0.00	0	+0.00
R018	50.00	2R-2C	E	0	+0.00	0	+0.00
R019	30.00	2R-2D	E	0	+0.00	0	+0.00
R020	30.00	2R-2E	E	0	+0.00	0	+0.00
R021	75.00	2R-3A	E	0	+0.00	0	+0.00
R022	175.00	2R-3B	E	0	+0.00	0	+0.00
R023	300.00	2R-3C	E	0	+0.00	0	+0.00
R024	130.00	2R-3D	E	0	+0.00	0	+0.00
R025	45.00	2R-3E	E	0	+0.00	0	+0.00
R026	370.00	2R-4A	E	0	+0.00	0	+0.00
R027	130.00	2R-4B	E	0	+0.00	0	+0.00
R028	230.00	2R-3F	E	0	+0.00	0	+0.00
R029	150.00	2R-3G	E	0	+0.00	0	+0.00
R030	30.00	2R-3J	E	0	+0.00	0	+0.00
R031	950.00	2R-3K	E	0	+0.00	0	+0.00
R032	175.00	2R-3L	E	0	+0.00	0	+0.00
R033	200.00	2R-3M	E	0	+0.00	0	+0.00
R034	50.00	2R-3N	E	0	+0.00	0	+0.00
R035	120.00	2R-3O	E	0	+0.00	0	+0.00
R036	25.00	2R-3P	E	0	+0.00	0	+0.00
R037	425.00	2R-3Q	E	0	+0.00	0	+0.00
R038	120.00	2R-3R	E	0	+0.00	0	+0.00
R039	20.00	2R-3S	E	0	+0.00	0	+0.00
R040	0.00	SCENIC VALUE 3RN	G	0	+0.00	0	+0.00
R041	0.00	AUXS-GRASS POWER 3RN	G	0	+0.00	0	+0.00
R042	0.00	AUXS-WOODSE 3RN	G	0	+0.00	0	+0.00
R043	0.00	RUNOFF-ACFI 3RN	E	0	+0.00	0	+0.00
R044	0.00	SEDIMENT-TONS 3RN	E	0	+0.00	0	+0.00
R045	0.00	SCENIC VALUE 2R	G	0	+0.00	0	+0.00
R046	0.00	AUXS-GRASS POWER 2R	G	0	+0.00	0	+0.00
R047	0.00	AUXS-WOODSE 2R	G	0	+0.00	0	+0.00
R048	0.00	RUNOFF-ACFI 2R	E	0	+0.00	0	+0.00
R049	0.00	SEDIMENT-TONS 2R	E	0	+0.00	0	+0.00
R050	0.00	SCENIC VALUE 2R	G	0	+0.00	0	+0.00
R051	0.00	COAL-TONS (AIRQ) 2R	E	0	+0.00	0	+0.00
R052	0.00	AUXS-GRASS POWER 2R	G	0	+0.00	0	+0.00
R053	0.00	AUXS-WOODSE 2R	G	0	+0.00	0	+0.00
R054	0.00	RUNOFF-ACFI 2R	E	0	+0.00	0	+0.00
R055	0.00	SEDIMENT-TONS 2R	E	0	+0.00	0	+0.00
R056	500.00	DEER UNITS 3RN	B	4	1.00	0	+0.00
R057	40.00	ELK UNITS 3RN	B	5	1.00	0	+0.00
R058	330.00	COW-CALF UNITS 3RN	B	1	1.00	0	+0.00
R059	12000.00	SEDIMENTATIONS 3RN	B	0	+0.00	3	1.00
R060	10000.00	RUNOFF-ACFI 3RN	B	0	1.00	0	+0.00
R061	324.00	RES DEER HUNTERS 3RN	B	8	1.00	0	+0.00
R062	30.00	RES ELK HUNTERS 3RN	B	7	1.00	0	+0.00
R063	725.00	NRES DEER HUNTERS 3RN	B	9	1.00	0	+0.00
R064	31.00	NRES ELK HUNTERS 3RN	B	10	1.00	0	+0.00
R065	440.00	DEER UNITS 2R	B	4	1.00	0	+0.00
R066	140.00	ELK UNITS 2R	B	5	1.00	0	+0.00
R067	225.00	COW-CALF UNITS 2R	B	1	1.00	0	+0.00
R068	12000.00	SEDIMENTATIONS 2R	B	0	+0.00	3	1.00
R069	10000.00	RUNOFF-ACFI 2R	B	0	1.00	0	+0.00
R070	574.00	RES DEER HUNTERS 2R	B	8	1.00	0	+0.00
R071	170.00	RES ELK HUNTERS 2R	B	7	1.00	0	+0.00
R072	2700.00	NRES DEER HUNTERS 2R	B	9	1.00	0	+0.00
R073	120.00	NRES ELK HUNTERS 2R	B	10	1.00	0	+0.00
R074	1600.00	DEER UNITS 2R	B	4	1.00	0	+0.00
R075	130.00	ELK UNITS 2R	B	5	1.00	0	+0.00
R076	900.00	COW-CALF UNITS 2R	B	1	1.00	0	+0.00
R077	20000.00	COAL-TONS (AIRQ) 2R	B	2	1.00	0	+0.00
R078	12000.00	SEDIMENTATIONS 2R	B	0	+0.00	3	1.00
R079	10000.00	RUNOFF-ACFI 2R	B	0	1.00	3	+0.00
R080	1500.00	RES DEER HUNTERS 2R	B	8	1.00	0	+0.00
R081	100.00	RES ELK HUNTERS 2R	B	7	1.00	0	+0.00
R082	3000.00	NRES DEER HUNTERS 2R	B	9	1.00	0	+0.00
R083	0.00	NRES ELK HUNTERS 2R	B	10	1.00	0	+0.00
R084	0.00	DEER UNITS 3RN	B	4	1.00	0	+0.00
R085	0.00	ELK UNITS 3RN	B	5	1.00	0	+0.00
R086	0.00	COW-CALF UNITS 3RN	B	1	1.00	0	+0.00
R087	0.00	RUNOFF-ACFI 3RN	B	0	+0.00	0	+0.00
R088	0.00	RES DEER HUNTERS 3RN	B	8	1.00	0	+0.00
R089	0.00	RES ELK HUNTERS 3RN	B	7	1.00	0	+0.00

OPTIMAL VALUE OF REAL VARIABLES

VARIABLE	DESCRIPTION	AMOUNT
X0[illegible]	30M-1A BRUSH CONTROL	75.00
X008	30M-1B BRUSH CONTROL	50.00
X012	30M-1C BRUSH CONTROL	25.00
X016	30M-1D GRAZING PGT	725.00
X019	30M-1E GRAZING PGT	125.00
X022	30M-1F ELK WINTER	200.00
X024	29-2A NO CHANGE	2700.00
X028	29-2B NO CHANGE	300.00
X032	29-2C NO CHANGE	50.00
X034	29-2D NO CHANGE	50.00
X037	29-2E NO CHANGE	50.00
X042	29-2F NO CHANGE	25.00
X045	29-2G NO CHANGE	25.00
X050	29-2H NO CHANGE	25.00
X055	29-2I NO CHANGE	75.00
X060	29-2J NO CHANGE	50.00
X063	29-2K NO CHANGE	100.00
X065	29-2L NO CHANGE	25.00
X067	29-2M NO CHANGE	50.00
X070	29-2N NO CHANGE	50.00
X075	28-3A BRUSH CONTROL	75.00
X078	28-3B BRUSH CONTROL	175.00
X079	28-3C NO CHANGE	300.00
X083	28-3D NO CHANGE	150.00
X086	28-3E NO CHANGE	25.00
X089	28-3F NO CHANGE	300.00
X093	28-3G NO CHANGE	354.84
X094	28-3G COAL DEVELOP	395.16
X096	28-3H COAL DEVELOP	250.00
X104	28-3I BRUSH CONTROL	750.00
X1[illegible]5	28-3J NO CHANGE	50.00
X1[illegible]8	28-3K NO CHANGE	950.00
X112	28-3L NO CHANGE	49.76
X115	28-3L BRUSH CONTROL	125.24
X118	28-3M NO CHANGE	200.00
X122	28-3N GRAZING PGT	50.00
X124	28-3O NO CHANGE	150.00
X125	28-3P NO CHANGE	25.00
X135	28-3Q BRUSH CONTROL	425.00
X136	28-3R NO CHANGE	150.00
X140	28-3S NO CHANGE	50.00
X146	30M COW-CALF AUMS	222.73
X147	30M SEDIMENT-TONS	842.25
X148	30M RUNOFF-ACFT	42.12
X149	30M RES DEER HUNTER	0.00
X150	30M RES ELK HUNTER	0.00
X153	29 DEER UNITS	933.20
X154	29 ELK UNITS	108.00
X155	29 COW-CALF AUMS	225.00
X156	29 SEDIMENT-TONS	3317.75
X157	29 RUNOFF-ACFT	39.77
X158	29 RES DEER HUNTER	974.00
X159	29 RES ELK HUNTER	108.00
X160	29 NRES DEER HUNTER	2090.00
X161	29 NRES ELK HUNTER	122.00
X162	28 DEER UNITS	1200.00
X163	28 ELK UNITS	163.00
X164	28 COW-CALF UNITS	585.00
X165	28 COAL-TONS	20000.00
X166	28 SEDIMENT-TONS	6993.58
X167	28 RUNOFF-ACFT	303.48
X168	28 RES DEER HUNTER	1560.00
X169	28 RES ELK HUNTER	178.00
X170	28 NRES DEER HUNTER	2454.55
X171	28 NRES ELK HUNTER	196.00

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                    GOAL ACHIEVEMENT
GOAL LEVEL     1 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *      R048. COW-CALF UNITS 30N   .
               IS UNDERACHIEVED BY         107.27 UNITS.
      * SUMMARY:
         GOAL      1 IS NOT ACHIEVED BY         107.27 WGTD UNITS.

GOAL LEVEL     2 IS*****************************COMPLETELY ACHIEVED.

GOAL LEVEL     3 IS*****************************COMPLETELY ACHIEVED.

GOAL LEVEL     4 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *      R050. DEER UNITS 30N          .
               IS UNDERACHIEVED BY         300.00 UNITS.
      * SUMMARY:
         GOAL      4 IS NOT ACHIEVED BY         300.00 WGTD UNITS.

GOAL LEVEL     5 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *      R057. ELK UNITS 30N           .
               IS UNDERACHIEVED BY          40.00 UNITS.
      * SUMMARY:
         GOAL      5 IS NOT ACHIEVED BY          40.00 WGTD UNITS.

GOAL LEVEL     6 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *      R059. RUNOFF-ACFT 30N         .
               IS UNDERACHIEVED BY        9957.87 UNITS.
        *      R069. RUNOFF-ACFT 29          .
               IS UNDERACHIEVED BY        9960.22 UNITS.
        *      R179. RUNOFF-ACFT 28          .
               IS UNDERACHIEVED BY        9696.52 UNITS.
      * SUMMARY:
         GOAL      6 IS NOT ACHIEVED BY       29614.62 WGTD UNITS.

GOAL LEVEL     7 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *      R062. FES ELK HUNTERS         .
               IS UNDERACHIEVED BY          36.00 UNITS.
      * SUMMARY:
         GOAL      7 IS NOT ACHIEVED BY          36.00 WGTD UNITS.

GOAL LEVEL     8 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *      R061. FES DEER HUNTERS 30N.
               IS UNDERACHIEVED BY         324.00 UNITS.
      * SUMMARY:
         GOAL      8 IS NOT ACHIEVED BY         324.00 WGTD UNITS.

GOAL LEVEL     9 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *      R063. FRES DEER HUNTER 30N.
               IS UNDERACHIEVED BY         720.00 UNITS.
        *      R032. FRES DEER HUNTERS 28.
               IS UNDERACHIEVED BY        1025.45 UNITS.
      * SUMMARY:
         GOAL      9 IS NOT ACHIEVED BY        1745.45 WGTD UNITS.

GOAL LEVEL    10 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
        *      R064. FRES ELK HUNTERS 30N.
               IS UNDERACHIEVED BY          41.00 UNITS.
      * SUMMARY:
         GOAL     10 IS NOT ACHIEVED BY          41.00 WGTD UNITS.
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GOAL SLACK ANALYSIS

THIS SECTION ANALYZES GOAL CONSTRAINTS WITH =>= TYPE INEQUALITIES WHERE EITHER A NEGATIVE OR POSITIVE DEVIATION IS NOT GIVEN A PRIORITY LEVEL. THE INDICATED WILL THEN REFLECT THE AMOUNT BY WHICH THE EXACT GOAL WAS NOT ACHIEVED, EVEN-THOUGH THE MINIMUM OR MAXIMUM GOAL LEVEL WAS ACHIEVED.

ROW NUMBER	GOAL DESCRIPTION	EXACT GOAL LEVEL	NEGATIVE SLACK	POSITIVE SLACK
R004	SEDIMENT-TONS 3YR	12000.00	11157.75	0000.00
R005	DEER UNITS 2Y	800.00	0000.00	133.20
R006	SEDIMENTS-TONS 2Y	12000.00	8862.25	0000.00
R078	SEDIMENT-TONS 2Y	12000.00	5000.42	0000.00

RESOURCE UTILIZATION ANALYSIS

ROW NUMBER	RESOURCE DESCRIPTION	EXACT RESOURCE LEVEL	RESOURCE NOT-USED	RESOURCE OVER-PRODUCED
R043	SCENIC VALUE 3YR	0.00	0000.00	2850.00
R042	AUMS-BROWSE 3YR	0.00	0000.00	125.27
R045	SCENIC VALUE 2Y	0.00	0000.00	7725.00
R044	AUMS-GRASS FORBS 2Y	0.00	0000.00	122.21
R047	AUMS-BROWSE 2Y	0.00	0000.00	478.93
R036	SCENIC VALUE 2Y	0.00	0000.00	18010.05
R033	AUMS-BROWSE 2Y	0.00	0000.00	425.71
R088	ELK UNITS 3Y	0.00	0000.00	73.02
R080	ELK UNITS 2Y	0.00	0000.00	107.44

APPENDIX 4

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$ PARAMETRIC RUN $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

$$ OF

$$ RIGHT-HAND-SIDE VALUE OF ROW P076

$$ AT A VALUE OF

$$ [illegible]

$$

*BECAME INFEASIBLE, ITERATION 0

FEASIBLE ON ITERATION 1

OPTIMAL VALUE OF REAL VARIABLES

VARIABLE	DESCRIPTION	AMOUNT
X004	30N-1A BRUSH CONTROL	75.00
X008	30N-1B BRUSH CONTROL	50.00
X012	30N-1C BRUSH CONTROL	25.00
X015	30N-1D GRAZING MGT	725.00
X019	30N-1E GRAZING MGT	125.00
X022	30N-1F ELK WINTER	200.00
X024	29-2A NO CHANGE	2700.00
X028	29-2B NO CHANGE	300.00
X032	29-2C NO CHANGE	50.00
X034	29-2D NO CHANGE	50.00
X037	29-2E NO CHANGE	50.00
X042	29-2F NO CHANGE	25.00
X045	29-2G NO CHANGE	25.00
X050	29-2H NO CHANGE	25.00
X055	29-2I NO CHANGE	75.00
X060	29-2J NO CHANGE	50.00
X063	29-2K NO CHANGE	100.00
X065	29-2L NO CHANGE	25.00
X067	29-2M NO CHANGE	50.00
X071	29-2N NO CHANGE	50.00
X075	28-3A BRUSH CONTROL	75.00
X078	28-3B BRUSH CONTROL	175.00
X082	28-3C GRAZING MGT	300.00
X084	28-3D COAL DEVELOP	118.51
X085	28-3D GRAZING MGT	31.49
X087	28-3E COAL DEVELOP	25.00
X090	28-3F COAL DEVELOP	300.00
X094	28-3G COAL DEVELOP	750.00
X098	28-3H COAL DEVELOP	250.00
X104	28-3I BRUSH CONTROL	750.00
X107	28-3J BRUSH CONTROL	50.00
X111	28-3K BRUSH CONTROL	950.00
X115	28-3L BRUSH CONTROL	175.00
X116	28-3M NO CHANGE	200.00
X122	28-3N GRAZING MGT	50.00
X127	28-3O BRUSH CONTROL	150.00
X131	28-3P BRUSH CONTROL	25.00
X135	28-3Q BRUSH CONTROL	425.00
X139	28-3R BRUSH CONTROL	150.00
X143	28-3S BRUSH CONTROL	50.00
X146	30N COW-CALF AUMS	222.73
X147	30N SEDIMENT-TONS	642.25
X148	30N RUNOFF-ACFT	42.12
X149	30N RES DEER HUNTER	0.00
X150	30N RES ELK HUNTER	0.00
X153	29 DEER UNITS	933.20
X154	29 ELK UNITS	108.00
X155	29 COW-CALF AUMS	225.00
X156	29 SEDIMENT-TONS	3317.75
X157	29 RUNOFF-ACFT	39.77
X158	29 RES DEER HUNTER	974.00
X159	29 RES ELK HUNTER	108.00
X160	29 NRES DEER HUNTER	2090.00
X161	29 NRES ELK HUNTER	122.00
X162	28 DEER UNITS	1200.00
X163	28 ELK UNITS	163.00
X164	28 COW-CALF UNITS	685.00
X165	28 COAL-TONS	44748.92
X166	28 SEDIMENT-TONS	7476.83
X167	28 RUNOFF-ACFT	321.69
X168	28 RES DEER HUNTER	1560.00
X169	28 RES ELK HUNTER	178.00
X170	28 NRES DEER HUNTER	2454.55
X171	28 NRES ELK HUNTER	196.00

GOAL ACHIEVEMENT

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GOAL LEVEL      1 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
     *          4047. COMMONF UNITS 30N      *
                IS UNDERACHIEVED BY          107.27 UNITS.
   * SUMMARY:
       GOAL      1 IS NOT ACHIEVED BY         107.27 WGTD UNITS.

GOAL LEVEL      2 IS**********************************COMPLETELY ACHIEVED.

GOAL LEVEL      3 IS**********************************COMPLETELY ACHIEVED.

GOAL LEVEL      4 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
     *          4 RO. ELK UNITS 30N          *
                IS UNDERACHIEVED BY          300.00 UNITS.
   * SUMMARY:
       GOAL      4 IS NOT ACHIEVED BY         300.00 WGTD UNITS.

GOAL LEVEL      5 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
     *          4047. ELK UNITS 30N          *
                IS UNDERACHIEVED BY           40.00 UNITS.
   * SUMMARY:
       GOAL      5 IS NOT ACHIEVED BY          40.00 WGTD UNITS.

GOAL LEVEL      6 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
     *          4048. RUPORT-ACFT 30N        *
                IS UNDERACHIEVED BY         9957.87 UNITS.
     *          4049. RUPORT-ACFT 2N         *
                IS UNDERACHIEVED BY         9960.22 UNITS.
     *          4079. RUPORT-ACFT 2R         *
                IS UNDERACHIEVED BY         9676.31 UNITS.
   * SUMMARY:
       GOAL      6 IS NOT ACHIEVED BY        29596.41 WGTD UNITS.

GOAL LEVEL      7 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
     *          4062. RES ELK HUNTERS        *
                IS UNDERACHIEVED BY           36.00 UNITS.
   * SUMMARY:
       GOAL      7 IS NOT ACHIEVED BY          36.00 WGTD UNITS.

GOAL LEVEL      8 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
     *          4061. RES DEER HUNTERS 30N.  *
                IS UNDERACHIEVED BY          324.00 UNITS.
   * SUMMARY:
       GOAL      8 IS NOT ACHIEVED BY         324.00 WGTD UNITS.

GOAL LEVEL      9 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
     *          4063. RES DEER HUNTER 30N.   *
                IS UNDERACHIEVED BY          720.00 UNITS.
     *          4062. RES DEER HUNTERS 2N.   *
                IS UNDERACHIEVED BY         1425.45 UNITS.
   * SUMMARY:
       GOAL      9 IS NOT ACHIEVED BY        1745.45 WGTD UNITS.

GOAL LEVEL     10 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
     *          4064. RES ELK HUNTERS 30N.   *
                IS UNDERACHIEVED BY           41.00 UNITS.
   * SUMMARY:
       GOAL     10 IS NOT ACHIEVED BY          41.00 WGTD UNITS.
```

GOAL SLACK ANALYSIS

THIS SECTION ANALYZES GOAL CONSTRAINTS WITH =>= TYPE INEQUALITIES WHERE EITHER A NEGATIVE OR POSITIVE DEVIATION IS NOT GIVEN A PRIORITY LEVEL. THE INDICATED WILL THEN REFLECT THE AMOUNT BY WHICH THE EXACT GOAL WAS NOT ACHIEVED, EVEN-THOUGH THE MINIMUM OR MAXIMUM GOAL LEVEL WAS ACHIEVED.

ROW NUMBER	GOAL DESCRIPTION	EXACT GOAL LEVEL	NEGATIVE SLACK	POSITIVE SLACK
R064	SEDIMENT-TONS 30N	12000.00	11157.78	0000.00
R065	DEER UNITS 29	800.00	0000.00	133.20
R066	SEDIMENT-TONS 29	12000.00	6882.25	0000.00
R077	COAL-TONS (X1000) 29	20000.00	0000.00	24748.92
R078	SEDIMENT-TONS 28	12000.00	4523.17	0000.00

RESOURCE UTILIZATION ANALYSIS

ROW NUMBER	RESOURCE DESCRIPTION	EXACT RESOURCE LEVEL	RESOURCE NOT-USED	RESOURCE OVER-PRODUCED
R040	SCENIC VALUE 30N	0.00	0000.00	2850.00
R042	AUMS-BROWSE 30N	0.00	0000.00	125.27
R045	SCENIC VALUE 29	0.00	0000.00	7725.00
R046	AUMS-GRASS FORBS 29	0.00	0000.00	122.21
R047	AUMS-BROWSE 29	0.00	0000.00	478.93
R050	SCENIC VALUE 28	0.00	0000.00	22692.57
R053	AUMS-BROWSE 28	0.00	0000.00	326.31
R088	ELK UNITS 29	0.00	0000.00	73.92
R089	ELK UNITS 28	0.00	0000.00	107.44

APPENDIX 5

CONSTRAINT SUMMARY

ROW NO.	ROW RIGHT-HAND-SIDE VALUE	ROW DESCRIPTION	ROW TYPE	NEGATIVE DEVIATIONS PRIORITY	NEGATIVE DEVIATIONS WEIGHT	POSITIVE DEVIATIONS PRIORITY	POSITIVE DEVIATIONS WEIGHT
R001	75.00	30N-1A	E	0	-0.00	0	-0.00
R002	50.00	30N-1B	E	0	-0.00	0	-0.00
R003	25.00	30N-1C	E	0	-0.00	0	-0.00
R004	725.00	30N-1D	E	0	-0.00	0	-0.00
R005	125.00	30N-1E	E	0	-0.00	0	-0.00
R006	200.00	30N-1F	E	0	-0.00	0	-0.00
R007	2700.00	29-2A	E	0	-0.00	0	-0.00
R008	300.00	29-2B	E	0	-0.00	0	-0.00
R009	50.00	29-2C	E	0	-0.00	0	-0.00
R010	50.00	29-2D	E	0	-0.00	0	-0.00
R011	50.00	29-2E	E	0	-0.00	0	-0.00
R012	25.00	29-2F	E	0	-0.00	0	-0.00
R013	25.00	29-2G	E	0	-0.00	0	-0.00
R014	25.00	29-2H	E	0	-0.00	0	-0.00
R015	75.00	29-2I	E	0	-0.00	0	-0.00
R016	50.00	29-2J	E	0	-0.00	0	-0.00
R017	100.00	29-2K	E	0	-0.00	0	-0.00
R018	25.00	29-2L	E	0	-0.00	0	-0.00
R019	50.00	29-2M	E	0	-0.00	0	-0.00
R020	50.00	29-2N	E	0	-0.00	0	-0.00
R021	75.00	28-3A	E	0	-0.00	0	-0.00
R022	175.00	28-3B	E	0	-0.00	0	-0.00
R023	300.00	28-3C	E	0	-0.00	0	-0.00
R024	150.00	28-3D	E	0	-0.00	0	-0.00
R025	25.00	28-3E	E	0	-0.00	0	-0.00
R026	300.00	28-3F	E	0	-0.00	0	-0.00
R027	750.00	28-3G	E	0	-0.00	0	-0.00
R028	250.00	28-3H	E	0	-0.00	0	-0.00
R029	750.00	28-3I	E	0	-0.00	0	-0.00
R030	50.00	28-3J	E	0	-0.00	0	-0.00
R031	950.00	28-3K	E	0	-0.00	0	-0.00
R032	175.00	28-3L	E	0	-0.00	0	-0.00
R033	200.00	28-3M	E	0	-0.00	0	-0.00
R034	50.00	28-3N	E	0	-0.00	0	-0.00
R035	150.00	28-3O	E	0	-0.00	0	-0.00
R036	25.00	28-3P	E	0	-0.00	0	-0.00
R037	425.00	28-3Q	E	0	-0.00	0	-0.00
R038	150.00	28-3R	E	0	-0.00	0	-0.00
R039	50.00	28-3S	E	0	-0.00	0	-0.00
R040	0.00	SCENIC VALUE 30N	G	0	-0.00	0	-0.00
R041	0.00	AUMS-GRASS FORBS 30N	G	0	-0.00	0	-0.00
R042	0.00	AUMS-BROWSE 30N	G	0	-0.00	0	-0.00
R043	0.00	RUNOFF-ACFT 30N	E	0	-0.00	0	-0.00
R044	0.00	SEDIMENT-TONS 30N	E	0	-0.00	0	-0.00
R045	0.00	SCENIC VALUE 29	G	0	-0.00	0	-0.00
R046	0.00	AUMS-GRASS FORBS 29	G	0	-0.00	0	-0.00
R047	0.00	AUMS-BROWSE 29	G	0	-0.00	0	-0.00
R048	0.00	RUNOFF-ACFT 29	E	0	-0.00	0	-0.00
R049	0.00	SEDIMENT-TONS 29	E	0	-0.00	0	-0.00
R050	0.00	SCENIC VALUE 28	G	0	-0.00	0	-0.00
R051	0.00	COAL-TONS (X10001 28	E	0	-0.00	0	-0.00
R052	0.00	AUMS-GRASS FORBS 28	G	0	-0.00	0	-0.00
R053	0.00	AUMS-BROWSE 28	G	0	-0.00	0	-0.00
R054	0.00	RUNOFF-ACFT 28	E	0	-0.00	0	-0.00
R055	0.00	SEDIMENT-TONS 28	E	0	-0.00	0	-0.00
R056	300.00	DEER UNITS 30N	B	4	1.00	0	-0.00
R057	40.00	ELK UNITS 30N	B	5	1.00	0	-0.00
R058	330.00	COW-CALF UNITS 30N	B	1	1.00	0	-0.00
R059	12300.00	SEDIMENT-TONS 30N	B	0	-0.00	3	1.00
R060	10000.00	RUNOFF-ACFT 30N	B	6	1.00	0	-0.00
R061	324.00	RES DEER HUNTERS 30N	B	8	1.00	0	-0.00
R062	36.00	RES ELK HUNTERS	B	7	1.00	0	-0.00
R063	720.00	NRES DEER HUNTER 30N	B	9	1.00	0	-0.00
R064	41.00	NRES ELK HUNTERS 30N	B	10	1.00	0	-0.00
R065	800.00	DEER UNITS 29	B	4	1.00	0	-0.00
R066	108.00	ELK UNITS 29	B	5	1.00	0	-0.00
R067	225.00	COW-CALF UNITS 29	B	1	1.00	0	-0.00
R068	12000.00	SEDIMENTS-TONS 29	B	0	-0.00	3	1.00
R069	10000.00	RUNOFF-ACFT 29	B	6	1.00	0	-0.00
R070	976.00	RES DEER HUNTERS 29	B	8	1.00	0	-0.00
R071	108.00	RES ELK HUNTERS 29	B	7	1.00	0	-0.00
R072	2090.00	NRES DEER HUNTERS 29	B	9	1.00	0	-0.00
R073	122.00	NRES ELK HUNTERS 29	B	10	1.00	0	-0.00
R074	1200.00	DEER UNITS 28	B	4	1.00	0	-0.00
R075	163.00	ELK UNITS 28	B	5	1.00	0	-0.00
R076	985.00	COW-CALF UNITS 28	B	1	1.00	0	-0.00
R077	20000.00	COAL-TONS (X10001 28	B	2	1.00	0	-0.00
R078	12000.00	SEDIMENT-TONS 28	B	0	-0.00	3	1.00
R079	10000.00	RUNOFF-ACFT 28	B	6	1.00	0	-0.00
R080	1590.00	RES DEER HUNTERS 28	B	8	1.00	0	-0.00
R081	178.00	RES ELK HUNTERS 28	B	7	1.00	0	-0.00
R082	3490.00	NRES DEER HUNTERS 28	B	9	1.00	0	-0.00
R083	196.00	NRES ELK HUNTERS 28	B	10	1.00	0	-0.00
R084	0.00	DEER UNITS 30N	G	0	-0.00	0	-0.00
R085	0.00	DEER UNITS 29	G	0	-0.00	0	-0.00
R086	0.00	DEER UNITS 28	G	0	-0.00	0	-0.00
R087	0.00	ELK UNITS 30N	G	0	-0.00	0	-0.00
R088	0.00	ELK UNITS 29	G	0	-0.00	0	-0.00
R089	0.00	ELK UNITS 28	G	0	-0.00	0	-0.00

OPTIMAL VALUE OF REAL VARIABLES

VARIABLE	DESCRIPTION	AMOUNT
X004	30N-1A BRUSH CONTROL	75.00
X008	30N-1B BRUSH CONTROL	50.00
X012	30N-1C BRUSH CONTROL	25.00
X016	30N-1D GRAZING MGT	725.00
X019	30N-1E GRAZING MGT	125.00
X022	30N-1F ELK WINTER	200.00
X024	29-2A NO CHANGE	2700.00
X028	29-2B NO CHANGE	300.00
X032	29-2C NO CHANGE	50.00
X034	29-2D NO CHANGE	50.00
X037	29-2E NO CHANGE	50.00
X042	29-2F NO CHANGE	25.00
X045	29-2G NO CHANGE	25.00
X050	29-2H NO CHANGE	25.00
X055	29-2I NO CHANGE	75.00
X060	29-2J NO CHANGE	50.00
X063	29-2K NO CHANGE	100.00
X065	29-2L NO CHANGE	25.00
X067	29-2M NO CHANGE	50.00
X070	29-2N NO CHANGE	50.00
X075	28-3A BRUSH CONTROL	75.00
X078	28-3B BRUSH CONTROL	175.00
X082	28-3C GRAZING MGT	300.00
X085	28-3D GRAZING MGT	150.00
X088	28-3E GRAZING MGT	25.00
X090	28-3F COAL DEVELOP	300.00
X094	28-3G COAL DEVELOP	16.50
X096	28-3G GRAZING MGT	733.50
X098	28-3H COAL DEVELOP	250.00
X104	28-3I BRUSH CONTROL	750.00
X107	28-3J BRUSH CONTROL	50.00
X111	28-3K BRUSH CONTROL	950.00
X115	28-3L BRUSH CONTROL	175.00
X119	28-3M BRUSH CONTROL	200.00
X122	28-3N GRAZING MGT	50.00
X127	28-3O BRUSH CONTROL	150.00
X131	28-3P BRUSH CONTROL	25.00
X135	28-3Q BRUSH CONTROL	425.00
X139	28-3R BRUSH CONTROL	150.00
X143	28-3S BRUSH CONTROL	50.00
X146	30N COW-CALF AUMS	222.73
X147	30N SEDIMENT-TONS	842.25
X148	30N RUNOFF-ACFT	42.12
X149	30N RES DEER HUNTER	0.00
X150	30N RES ELK HUNTER	0.00
X153	29 DEER UNITS	933.20
X154	29 ELK UNITS	108.00
X155	29 COW-CALF AUMS	225.00
X156	29 SEDIMENT-TONS	3317.75
X157	29 RUNOFF-ACFT	39.77
X158	29 RES DEER HUNTER	974.00
X159	29 RES ELK HUNTER	108.00
X160	29 NRES DEER HUNTER	2090.00
X161	29 NRES ELK HUNTER	122.00
X164	28 COW-CALF UNITS	985.00
X165	28 COAL-TONS	17561.60
X166	28 SEDIMENT-TONS	5244.53
X167	28 RUNOFF-ACFT	220.08
X170	28 NRES DEER HUNTER	0.00

GOAL ACHIEVEMENT

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GOAL LEVEL      1 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
      *         R058, COW-CALF UNITS 30N  ,
                IS UNDERACHIEVED BY        107.27 UNITS.
      * SUMMARY:
        GOAL      1 IS NOT ACHIEVED BY        107.27 WGTD UNITS.

GOAL LEVEL      2 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
      *         R077, COAL-TONS (X1000) 28,
                IS UNDERACHIEVED BY       2438.40 UNITS.
      * SUMMARY:
        GOAL      2 IS NOT ACHIEVED BY       2438.40 WGTD UNITS.

GOAL LEVEL      3 IS**************************COMPLETELY ACHIEVED.

GOAL LEVEL      4 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
      *         R056, DEER UNITS 30N      ,
                IS UNDERACHIEVED BY        300.00 UNITS.
      *         R074, DEER UNITS 28       ,
                IS UNDERACHIEVED BY       1200.00 UNITS.
      * SUMMARY:
        GOAL      4 IS NOT ACHIEVED BY       1500.00 WGTD UNITS.

GOAL LEVEL      5 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
      *         R057, ELK UNITS 30N       ,
                IS UNDERACHIEVED BY         40.00 UNITS.
      *         R075, ELK UNITS 28        ,
                IS UNDERACHIEVED BY        163.00 UNITS.
      * SUMMARY:
        GOAL      5 IS NOT ACHIEVED BY        203.00 WGTD UNITS.

GOAL LEVEL      6 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
      *         R060, RUNOFF-ACFT 30N     ,
                IS UNDERACHIEVED BY       9937.87 UNITS.
      *         R069, RUNOFF-ACFT 29      ,
                IS UNDERACHIEVED BY       9960.22 UNITS.
      *         R079, RUNOFF-ACFT 28      ,
                IS UNDERACHIEVED BY       9779.92 UNITS.
      * SUMMARY:
        GOAL      6 IS NOT ACHIEVED BY      29698.02 WGTD UNITS.

GOAL LEVEL      7 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
      *         R062, RES ELK HUNTERS     ,
                IS UNDERACHIEVED BY         36.00 UNITS.
      *         R081, RES ELK HUNTERS 28  ,
                IS UNDERACHIEVED BY        178.00 UNITS.
      * SUMMARY:
        GOAL      7 IS NOT ACHIEVED BY        214.00 WGTD UNITS.

GOAL LEVEL      8 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
      *         R061, RES DEER HUNTERS 30N,
                IS UNDERACHIEVED BY        324.00 UNITS.
      *         R080, RES DEER HUNTERS 28 ,
                IS UNDERACHIEVED BY       1560.00 UNITS.
      * SUMMARY:
        GOAL      8 IS NOT ACHIEVED BY       1884.00 WGTD UNITS.

GOAL LEVEL      9 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
      *         R063, NRES DEER HUNTER 30N,
                IS UNDERACHIEVED BY        720.00 UNITS.
      *         R082, NRES DEER HUNTERS 28,
                IS UNDERACHIEVED BY       3480.00 UNITS.
      * SUMMARY:
        GOAL      9 IS NOT ACHIEVED BY       4200.00 WGTD UNITS.

GOAL LEVEL     10 IS NOT ACHIEVED IN THE FOLLOWING CONSTRAINTS:
      *         R064, NRES ELK HUNTERS 30N,
                IS UNDERACHIEVED BY         41.00 UNITS.
      *         R083, NRES ELK HUNTERS 28 ,
                IS UNDERACHIEVED BY        196.00 UNITS.
      * SUMMARY:
        GOAL     10 IS NOT ACHIEVED BY        237.00 WGTD UNITS.
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GOAL SLACK ANALYSIS

THIS SECTION ANALYZES GOAL CONSTRAINTS WITH -B- TYPE INEQUALITIES WHERE EITHER A NEGATIVE OR POSITIVE DEVIATION IS NOT GIVEN A PRIORITY LEVEL. THE INDICATED WILL THEN REFLECT THE AMOUNT BY WHICH THE EXACT GOAL WAS NOT ACHIEVED. EVEN-THOUGH THE MINIMUM OR MAXIMUM GOAL LEVEL WAS ACHIEVED.

ROW NUMBER	GOAL DESCRIPTION	EXACT GOAL LEVEL	NEGATIVE SLACK	POSITIVE SLACK
R059	SEDIMENT-TONS 30N	12000.00	11157.75	0000.00
R065	DEER UNITS 29	800.00	0000.00	133.20
R068	SEDIMENTS-TONS 29	12000.00	8682.25	0000.00
R078	SEDIMENT-TONS 28	12000.00	6755.47	0000.00

RESOURCE UTILIZATION ANALYSIS

ROW NUMBER	RESOURCE DESCRIPTION	EXACT RESOURCE LEVEL	RESOURCE NOT-USED	RESOURCE OVER-PRODUCED
R040	SCENIC VALUE 30N	0.00	0000.00	2850.00
R042	AUMS-BROWSE 30N	0.00	0000.00	125.27
R045	SCENIC VALUE 29	0.00	0000.00	7725.00
R046	AUMS-GRASS FORBS 29	0.00	0000.00	122.21
R047	AUMS-BROWSE 29	0.00	0000.00	478.93
R050	SCENIC VALUE 28	0.00	0000.00	18707.52
R053	AUMS-BROWSE 28	0.00	0000.00	739.37
R088	ELK UNITS 29	0.00	0000.00	73.92
R089	ELK UNITS 28	0.00	0000.00	0.00

APPENDIX 6

This Appendix contains the natural resource coefficients for the North Fork Planning Unit. Part I contains the utilization coefficients and Part II contains the resource production coefficients for four management alternatives: as is, grazing management, brush control, and coal mining.

I. Utilization Coefficients

A. Forage

1. Type

Type Animal	Percent of Diet: Grass & Forbs	Percent of Diet: Browse
Cows	94	6
Sheep	68	32
Deer	41	59
Elk	75	25

2. Quantity

Type Animal	AUM Required
Cows	1.00
Sheep	0.20
Deer	0.20
Elk	0.75

B. Big Game Hunting

1. Deer

Success rate	58%
Resident harvest	43%
Non-resident harvest	57%
Resident hunter days	5.17
Non-resident hunter days	8.91

2. Elk

Success rate	30%
Resident harvest	60%
Non-resident harvest	40%
Resident hunter days	6.27
Non-resident hunter days	8.63

C. Disturbed Lands

Coal mining and brush control management practices will change the scenic rating of the response unit from its current value to a 5.

II. Production Coefficients

A. Vegetation

PJ - Pinyon-Juniper
MS - Mountain shrub
BT - Broadleaf trees
SS - Shadscale
SB - Sagebrush
GW - Greasewood

B. Soil

BC - Brown chestnut
MPC - Mountain prairie, chestnut
DS - Desert sierozem
GP - Gray wooded - Brown pozolic - Mountain prairie

C. Slope - Degrees

D. Erosion - Class

STA - Stable
MOD - Moderate
CRT - Critical

Allotment/ response units	Acres	Vegetation	Soil	Slope	Erosion class	Acres of coal	Scenic rating	Acres deer winter range	Acres elk winter range	Current Management: AUM's grass forbs/acre	AUM's Browse/ acre	Tons sediment /acre	Acre feet H_2O/acre
1A	525	PJ	BC	0-15	STA	25	3		200	.08	.12		
B	100	PJ	BC	16-25	STA	25	3		75	.08	.12		
C	25	PJ	BC	>25	STA		3		25	.08	.12		
D	700	PJ	MPC	0-15	STA	300	3		100	.08	.12		
E	450	PJ	MPC	16-25	STA	100	3		100	.08	.12		
F	75	PJ	MPC	>25	STA		3			.08	.12		
G	2800	MS	MPC	0-15	STA	2675	2			.13	.20		
H	1350	MS	MPC	16-25	STA	1175	2			.13	.20		
I	75	MS	MPC	>25	STA	25	2			.13	.20		
2A	75	SB	BC	0-15	STA		4	75		.10	.10		
B	450	PJ	BC	0-15	STA		3	450		.08	.12		
C	50	PJ	BC	16-25	STA		3	50		.08	.12		
D	25	BT	MPC	16-25	STA		1	25		.16	.20		
E	25	PJ	MPC	0-15	STA		3	25		.08	.12		
F	75	PJ	MPC	16-25	STA		3	75		.08	.12		
3A	525	MS	MPC	0-15	STA		2		525	.13	.20		
B	275	MS	MPC	16-25	STA		2		275	.13	.20		
4A	500	PJ	BC	0-15	STA		3	50		.08	.12	1.10	.015
B	625	PJ	BC	16-25	STA		3	275		.08	.12	1.35	.018
C	175	PJ	BC	>25	STA		3	150		.08	.12	1.93	.020
D	250	PJ	MPC	0-15	STA		3	250		.08	.12	1.10	.015
E	175	PJ	MPC	16-25	STA		3	175		.08	.12	1.35	.018
F	100	PJ	MPC	>25	STA		3	100		.08	.12	1.93	.020
G	350	MS	MPC	0-15	STA	350	2	350		.13	.20	0.93	.010
H	50	MS	MPC	16-25	STA	50	2	50		.13	.20	1.10	.013
5A	125	SB	BC	0-15	STA		4			.10	.10	1.00	.010
B	275	PJ	BC	0-15	STA		3	250		.08	.12	1.00	.015
C	125	PJ	BC	16-25	STA		3	100		.08	.12	1.25	.018
D	50	PJ	BC	>25	STA		3	50		.08	.12	1.78	.020
6A	750	MS	MPC	0-15	STA		2		650	.13	.20	0.55	.010
B	150	MS	MPC	>25	STA	500	2		150	.13	.20	0.95	.015
7A	850	PJ	BC	0-15	STA		3	350		.08	.12	0.95	.015
B	250	PJ	BC	0-15	MOD		3	150		.08	.12	1.78	.025
C	200	PJ	BC	16-25	STA		3	50		.08	.12	1.20	.018
D	75	PJ	BC	16-25	MOD		3	75		.08	.12	2.125	.028

Allotment/ response units	Grazing Management				Brush Control Management				Coal Mining		
	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Tons/ acre	Run-off	Sediment
1A			.020	No change			.13	.07	25,000		
B			.020	No change			.13	.07	25,000		
C			.020	No change							
D			.020	No change			.13	.07	25,000		
E			.020	No change			.13	.07	25,000		
F			.020	No change							
G			.035	No change					25,000		
H			.035	No change					25,000		
I			.035	No change					25,000		
2A			.027	No change			.02				
B			.020	No change			.13	.07			
C			.020	No change			.13	.07			
D			.040	No change							
E			.020	No change			.13	.07			
F			.020	No change			.13	.07			
3A			.032	No change							
B			.032	No change							
4A	.0120	0.935	.019	No change	.0105	0.825	.13	.07			
B	.0144	1.148	.019	No change	.0126	1.013	.13	.07			
C	.0160	1.641	.019	No change							
D	.0120	0.935	.019	No change	.0105	0.825	.13	.07			
E	.0144	1.148	.019	No change	.0126	1.013	.13	.07			
F	.0160	1.641	.019	No change							
G	.0080	0.791	.032	No change					25,000	.06	4.50
H	.0104	0.935	.032	No change					25,000	.06	5.25
5A	.0080	0.850	.025	No change	.0070	0.800	.02				
B	.0120	0.850	.019	No change	.0105	0.800	.13	.07			
C	.0144	1.061	.019	No change	.0130		.13	.07			
D	.0160	1.510	.019	No change							
6A	.0080	0.466	.032	No change					25,000	.06	4.50
B	.0120	0.806	.032	No change							
7A	.0120	0.806	.018	No change	.0110	0.713	.13	.07			
B	.0200	1.510	.018	No change	.0170	1.340	.13	.07			
C	.0144	1.020	.018	No change	.0130	0.900	.13	.07			
D	.0224	1.810	.018	No change	.0200	1.590	.13	.07			

Allotment/ response units	Acres	Vegetation	Soil	Slope	Erosion class	Acres of coal	Scenic rating	Acres deer winter range	Acres elk winter range	Current Management: AUM's grass forbs/acre	AUM's Browse/ acre	Tons sediment /acre	Acre feet H_2O/acre
7E	150	PJ	BC	> 25	STA		3			.08	.12	1.680	.020
F	25	PJ	BC	> 25	MOO		3			.08	.12	3.130	.030
G	550	PJ	MPC	0-15	STA		3		450	.08	.12	0.950	.015
H	650	PJ	MPC	0-15	MOO		3		650	.08	.12	1.780	.025
I	75	PJ	MPC	16-25	STA		3		75	.08	.12	1.200	.018
J	225	PJ	MPC	16-25	MOO		3		225	.08	.12	2.125	.028
K	100	PJ	MPC	> 25	STA		3		125	.08	.12	1.680	.020
L	50	PJ	MPC	> 25	MOO		3		50	.08	.12	3.130	.030
M	600	MS	MPC	0-15	STA	325	2		375	.13	.20	0.800	.010
N	75	MS	MPC	16-25	STA		2		75	.13	.20	0.950	.013
O	150	MS	MPC	> 25	STA		2			.13	.20	1.400	.015
8A	25	BT	MPC	0-15	STA	25	1		25	.16	.20	0.680	.010
B	75	BT	MPC	16-25	STA	75	1			.16	.20	0.800	.010
9A	250	MS	MPC	0-15	STA	250	2		250	.13	.20	0.850	.010
B	50	MS	MPC	16-25	STA	50	2		50	.13	.20	1.000	.013
10A	75	BT	MPC	0-15	STA	75	1		75	.16	.20		
B	25	BT	MPC	16-25	STA	25	1		25	.16	.20		
C	275	MS	MPC	0-15	STA	275	2		275	.13	.20		
D	25	MS	MPC	16-25	STA	25	2		25	.13	.20		
11A	100	MS	MPC	0-15	STA	100	2		100	.13	.20		
B	150	MS	MPC	16-25	STA	150	2		150	.13	.20		
12A	1275	PJ	BC	0-15	MOO		3		375	.08	.12	1.480	.025
B	650	PJ	BC	16-25	MOO		3		225	.08	.12	1.780	.028
C	525	PJ	BC	> 25	MOD		3		150	.08	.12	2.500	.030
D	25	MS	BC	16-25	STA	25	2			.13	.20	1.000	.013
E	25	PJ	MPC	0-15	STA	25	3		25	.08	.12	1.000	.015
F	25	PJ	MPC	16-25	STA		3		25	.08	.12	1.250	.018
G	175	PJ	MPC	0-15	MOD		3		150	.08	.12	1.480	.025
H	125	PJ	MPC	16-25	MOO		3		125	.08	.12	1.780	.028
I	650	MS	MPC	0-15	STA	625	2		600	.13	.20	0.850	.010
J	575	MS	MPC	16-25	STA	525	2		500	.13	.20	1.000	.013
13A	250	MS	MPC	0-15	STA	250	2		250	.13	.20	0.930	.010
B	50	MS	MPC	16-25	STA	50	2		50	.13	.12	1.100	.013
14A	25	PJ	MPC	0-15	STA	25	3		25	.08	.20	1.100	.015
B	200	PJ	MPC	16-25	STA	200	3		200	.08	.20	1.350	.018

Allotment/ response units	Grazing Management				Brush Control Management				Coal Mining		
	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Tons/ acre	Run-off	Sediment
7E	.0160	1.430	.018	No change							
F	.0240	2.660	.018	No change							
G	.0120	0.806	.018	No change	.011	0.713	.13	.07			
H	.0200	1.510	.018	No change	.017	1.340	.13	.07			
I	.0144	1.020	.018	No change	.013	0.900	.13	.07			
J	.0224	1.810	.018	No change	.020	1.590	.13	.07			
K	.0160	1.430	.018	No change							
L	.0240	2.660	.018	No change							
M	.0080	0.680	.029	No change					25,000	.06	4.50
N	.0104	0.806	.029	No change							
O	.0120	1.190	.029	No change							
8A	.0080	0.578	.035	No change					25,000	.06	4.50
B	.0080	0.680	.035	No change					25,000	.06	6.25
9A	.0080	0.722	.029	No change					25,000	.06	4.50
B	.0104	0.850	.029	No change					25,000	.06	6.25
10A			.035	No change					36,000		
B			.035	No change					36,000		
C			.029	No change					36,000		
D			.029	No change					36,000		
11A			.033	No change					36,000		
B			.033	No change					36,000		
12A	.020	1.260	.019	No change	.018	1.110	.13	.07			
B	.022	1.510	.018	No change	.020	1.330	.13	.07			
C	.024	2.120	.018	No change							
D	.010	0.850	.029	No change					25,000	.06	6.25
E	.012	0.850	.018	No change	.011	0.750	.13	.07	25,000	.06	4.50
F	.014	1.060	.018	No change	.013	0.935	.13	.07			
G	.020	1.260	.018	No change	.018	1.110	.13	.07			
H	.022	1.510	.018	No change	.020	1.330	.13	.07			
I	.008	0.724	.029	No change					27,000	.06	4.50
J	.010	0.008	.029	No change					27,000	.06	6.25
13A	.008	0.791	.033	No change					26,000	.06	4.50
B	.010	0.935	.033	No change					26,000	.06	6.25
14A	.012	0.935	.020	No change	.011	0.825	.13	.07	26,000	.06	4.50
B	.014	1.150	.020	No change	.013	1.010	.13	.07	26,000	.06	6.25

Allotment/ response units	Acres	Vegetation	Soil	Slope	Erosion class	Acres of coal	Scenic rating	Acres deer winter range	Acres elk winter range	Current Management: AUM's grass forbs/acre	AUM's Browse/ acre	Tons sediment /acre	Acre feet H_2O/acre
C	25	PJ	MPC	>25	STA	25	3		25	.08	.20	1.93	.020
D	25	MS	MPC	0-15	STA	25	2		25	.13	.20	0.93	.010
E	300	MS	MPC	16-25	STA	150	2		100	.13	.20	1.10	.013
F	25	MS	MPC	>25	STA	25	2			.13	.20	1.60	.015
G	25	MS	BC	0-15	STA		2			.13	.20	0.93	.010
H	50	MS	BC	16-25	STA		2			.13	.20	1.10	.013
I	150	PJ	BC	0-15	STA		3	75		.08	.12	1.10	.015
J	375	PJ	BC	16-25	STA		3	250		.08	.12	1.35	.018
K	25	PJ	BC	0-15	MOD		3			.08	.12	1.60	.025
L	75	PJ	BC	>25	MOD		3			.08	.12	2.30	.030
15A	550	PJ	BC	0-15	STA		3	425		.08	.12	1.10	.015
B	300	PJ	BC	16-25	STA	75	3	175		.08	.12	1.35	.018
C	137	BT	BC	16-25	STA	137	1	150		.16	.20	0.93	.010
D	600	MS	BC	0-15	STA	200	2	600		.13	.20	0.93	.010
E	750	MS	BC	16-25	STA	400	2	650		.13	.20	1.10	.013
F	100	MS	BC	>25	STA	75	2	75		.13	.20	1.60	.015
G	25	PJ	MPC	16-25	STA	25	3	25		.08	.12	1.35	.018
H	150	BT	MPC	0-15	STA	150	1	50		.16	.20	0.78	.010
I	250	BT	MPC	16-25	STA	250	1			.16	.20	0.93	.010
J	25	BT	MPC	>25	STA	25	1			.16	.20	1.35	.010
K	375	MS	MPC	0-15	STA	375	2		125	.13	.20	0.93	.010
L	550	MS	MPC	16-25	STA	475	2		350	.13	.20	1.10	.013
M	125	MS	MPC	>25	STA	75	2		75	.13	.20	1.60	.015
16A	50	PJ	BC	16-25	STA	50	3		25	.08	.12	1.08	.018
B	125	PJ	BC	>25	STA	50	3		100	.08	.12	2.22	.020
C	50	MS	BC	0-15	STA	50	2		50	.13	.20	0.75	.010
D	50	MS	BC	16-25	STA	50	2		50	.13	.20	0.90	.013
E	50	MS	BC	>25	STA	50	2		50	.13	.20	1.30	.015
F	75	BT	MPC	0-15	STA	50	1			.16	.20	0.63	.010
G	50	BT	MPC	16-25	STA	50	1			.16	.20	0.75	.010
H	100	MS	MPC	0-15	STA	100	2		50	.13	.20	0.63	.010
I	150	MS	MPC	16-25	STA	125	2		125	.13	.20	0.75	.013
J	75	MS	MPC	>25	STA	75	2		75	.13	.20	1.08	.015
17A	14	BT	MPC	16-25	STA		1			.16	.20	0.68	.010
18A	75	PJ	BC	0-15	STA	75	3			.08	.12	0.95	.015

Allotment/ response units	Grazing Management				Brush Control Management				Coal Mining		
	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Tons/ acre	Run-off	Sediment
C	.0160	1.640	.020	No change					36,000	.06	7.50
D	.0080	0.791	.033	No change					36,000	.06	4.25
E	.0100	0.935	.033	No change					36,000	.06	6.25
F	.0120	1.360	.033	No change					36,000	.06	7.50
G	.0080	0.791	.033	No change							
H	.0100	0.935	.033	No change							
I	.0120	0.935	.020	No change	.0110	0.825	.13	.07			
J	.0140	1.150	.020	No change	.0130	1.010	.13	.07			
K	.0200	1.360	.020	No change	.0180	1.200	.13	.07			
L	.0240	1.960	.020	No change							
15A	.0120	0.935	.020	No change	.0110	0.825	.13	.07			
B	.0140	1.150	.020	No change	.0130	1.010	.13	.07	36,000	.06	6.25
C	.0080	0.790	.040	No change					36,000	.06	6.25
D	.0080	0.790	.030	No change					36,000	.06	4.50
E	.0100	0.935	.030	No change					36,000	.06	6.25
F	.0120	1.360	.030	No change					36,000	.06	7.50
G	.0140	1.150	.020	No change	.0130	1.010	.13	.07	36,000	.06	6.25
H	.0080	0.663	.040	No change					36,000	.06	4.50
I	.0080	0.790	.040	No change					36,000	.06	6.25
J	.0080	1.150	.040	No change					36,000	.06	7.50
K	.0080	0.790	.030	No change					36,000	.06	4.50
L	.0100	0.935	.030	No change					36,000	.06	6.25
M	.0120	1.360	.030	No change					36,000	.06	7.50
16A	.0140	0.919	.020	No change	.0130	0.810	.13	.07	36,000	.06	6.25
B	.0160	1.890	.020	No change					36,000	.06	7.50
C	.0080	0.637	.030	No change					36,000	.06	4.50
D	.0100	0.765	.030	No change					36,000	.06	6.25
E	.0120	1.100	.030	No change					36,000	.06	7.50
F	.0080	0.535	.040	No change					36,000	.06	4.50
G	.0080	0.637	.040	No change					36,000	.06	6.25
H	.0080	0.535	.030	No change					36,000	.06	4.50
I	.0100	0.637	.030	No change					36,000	.06	6.25
J	.0120	0.919	.030	No change					36,000	.06	7.50
17A	.0080	0.578	.040	No change							
18A	.0120	0.807	.018	No change	.0110	0.712	.13	.07	36,000	.06	4.50

Allotment/ resopnse units	Acres	Vegetation	Soil	Slope	Erosion class	Acres of coal	Scenic rating	Acres deer winter range	Acres elk winter range	Current Management: AUM's grass forbs/acre	AUM's Browse/ acre	Tons sediment /acre	Acre feet H_2O/acre
B	325	PJ	BC	16-25	STA	325	3			.08	.12	1.20	.018
C	425	PJ	BC	> 25	STA	425	3			.08	.12	1.68	.020
D	25	PJ	MPC	0-15	STA	25	3			.08	.12	0.95	.015
E	25	PJ	MPC	16-25	STA	25	3			.08	.12	1.20	.018
F	75	PJ	MPC	> 25	STA	75	3			.08	.12	1.68	.020
G	125	BT	MPC	16-25	STA	125	1		125	.16	.20	0.68	.010
H	75	BT	MPC	> 25	STA	75	1			.16	.20	0.80	.010
I	75	MS	MPC	0-15	STA	75	2			.13	.20	0.80	.010
J	225	MS	MPC	16-25	STA	225	2			.13	.20	0.95	.013
K	200	MS	MPC	> 25	STA	200	2			.13	.20	1.40	.015
19A	25	MS	BC	0-15	STA	25	2			.13	.20	0.80	.010
B	250	MS	BC	16-25	STA	250	2			.13	.20	0.95	.013
C	200	MS	BC	> 25	STA	200	2			.13	.20	1.40	.015
D	25	MS	MPC	0-15	STA		2			.13	.20	0.80	.010
E	250	MS	MPC	16-25	STA	200	2			.13	.20	0.95	.013
F	275	MS	MPC	> 25	STA	275	2			.13	.20	1.40	.015
20A	25	MS	BC	16-25	STA	25	2			.13	.20	0.78	.013
B	25	MS	BC	> 25	STA	25	2			.13	.20	1.10	.015
C	25	MS	MPC	0-15	STA	25	2			.13	.20	0.65	.010
D	125	MS	MPC	16-25	STA	125	2			.13	.20	0.78	.013
E	350	MS	MPC	> 25	STA	350	2			.13	.20	1.10	.015
21A	12	MS	BC	> 25	STA	12.5	2			.13	.20	1.20	.015
B	25	BT	MPC	16-25	STA	25	1			.16	.20	0.68	.010
C	25	BT	MPC	> 25	STA	25	1			.16	.20	0.95	.010
D	1325	MS	MPC	0-15	STA	1250	2			.13	.20	0.68	.010
E	900	MS	MPC	16-25	STA	775	2			.13	.20	0.80	.013
F	887	MS	MPC	> 25	STA	877.5	2			.13	.20	1.20	.015
22A	475	MS	MPC	0-15	STA	88	2			.13	.20	0.68	.010
B	350	MS	MPC	16-25	STA	100	2			.13	.20	0.80	.013
C	350	MS	MPC	> 25	STA	125	2			.13	.20	1.20	.015
23A	50	MS	MPC	16-25	STA		2			.13	.20	0.80	.013
B	50	MS	MPC	> 25	STA		2			.13	.20	1.20	.015
24A	25	BT	MPC	0-15	STA		1	25	25	.16	.20	0.55	.010
B	100	MS	MPC	0-15	STA		2			.13	.20	0.68	.010
C	150	MS	MPC	16-25	STA		2	25	25	.13	.20	0.80	.013

Allotment/ response units	Grazing Management				Brush Control Management				Coal Mining		
	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Tons/ acre	Run-off	Sediment
B	.0140	1.020	.0180	No change	.0130	0.960	.13	.07	36,000	.06	6.25
C	.0160	1.430	.0180	No change					36,000	.06	7.50
D	.0120	0.807	.0180	No change	.0110	0.712	.13	.07	36,000	.06	4.50
E	.0140	1.020	.0180	No change	.0130	0.960	.13	.07	36,000	.06	6.25
F	.0160	1.430	.0180	No change					36,000	.06	7.50
G	.0080	0.578	.0350	No change					36,000	.06	6.25
H	.0080	0.640	.0350	No change					36,000	.06	7.50
I	.0080	0.640	.0280	No change					36,000	.06	4.50
J	.0100	0.807	.0280	No change					36,000	.06	6.25
K	.0120	1.190	.0280	No change					36,000	.06	7.50
19A	.0080	0.640	.0250	No change					36,000	.06	4.50
B	.0100	0.807	.0250	No change					36,000	.06	6.25
C	.0120	1.190	.0250	No change					36,000	.06	7.50
D	.0080	0.640	.0250	No change							
E	.0100	0.807	.0250	No change					36,000	.06	6.25
F	.0120	1.190	.0250	No change					36,000	.06	7.50
20A	.0100	0.673	.0250	No change					36,000	.06	6.25
B	.0120	0.880	.0250	No change					36,000	.06	7.50
C	.0080	0.553	.0250	No change					36,000	.06	4.50
D	.0100	0.673	.0250	No change					36,000	.06	6.25
E	.0120	0.880	.0250	No change					36,000	.06	7.50
21A	.0120	1.020	.0250	No change					36,000	.06	7.50
B	.0080	0.577	.0030	No change					36,000	.06	6.25
C	.0080	0.806	.0030	No change					36,000	.06	7.50
D	.0080	0.577	.0250	No change					36,000	.06	4.50
E	.0100	0.679	.0250	No change					36,000	.06	6.25
F	.0120	1.020	.0250	No change					36,000	.06	7.50
22A	.0080	0.577	.0250	No change					31,000	.06	4.50
B	.0100	0.679	.0250	No change					31,000	.06	6.25
C	.0120	1.020	.0250	No change					31,000	.06	7.50
23A	.0100	0.679	.0250	No change							
B	.0120	1.020	.0250	No change							
24A	.0080	0.466	.0030	No change							
B	.0080	0.577	.0250	No change							
C	.0100	0.679	.0250	No change							

Allotment/ response units	Acres	Vegetation	Soil	Slope	Erosion class	Acres of coal	Scenic rating	Acres deer winter range	Acres elk winter range	Current Management: AUM's grass forbs/acre	AUM's Browse/ acre	Tons sediment /acre	Acre feet H_2O/acre
D	325	MS	MPC	>25	STA		2			.13	.20	1.20	.015
E	25	BT	GP	0-15	STA		1			.16	.20	0.55	.010
F	600	MS	GP	0-15	STA		2		375	.13	.20	0.68	.010
G	175	MS	GP	16-25	STA		2		175	.13	.20	0.80	.013
H	25	MS	GP	>25	STA		2		25	.13	.20	1.20	.015
25A	58	MS	GP	0-15	STA		2			.13	.20	0.68	.010
26A	50	MS	MPC	0-15	STA		2			.13	.20	0.80	.010
B	75	MS	MPC	>25	STA		2			.13	.20	1.40	.015
27A	50	MS	MPC	0-15	STA		2			.13	.20	0.68	.010
B	125	MS	MPC	16-25	STA		2			.13	.20	0.80	.013
C	150	MS	MPC	>25	STA		2			.13	.20	1.40	.015
28A	75	PJ	BC	0-15	STA		3			.08	.12	0.88	.015
B	175	PJ	BC	16-25	STA		3			.08	.12	1.25	.015
C	300	BT	MPC	0-15	STA	300	1	75		.16	.20	0.50	.010
D	150	BT	MPC	16-25	STA	150	1			.16	.20	0.75	.010
E	25	BT	MPC	>25	STA	25	1			.16	.20	0.88	.010
F	300	MS	MPC	0-15	STA	225	2	175		.13	.20	0.63	.010
G	750	MS	MPC	16-25	STA	675	2	350		.13	.20	1.00	.010
H	250	MS	MPC	>25	STA	200	2	175		.13	.20	1.13	.010
I	750	PJ	MPC	0-15	STA		3	425		.08	.12	0.88	.015
J	50	PJ	MPC	0-15	CRT		3			.08	.12	2.25	.034
K	950	PJ	MPC	16-25	STA		3	800		.08	.12	1.25	.015
L	175	PJ	MPC	16-25	CRT		3	175		.08	.12	3.30	.034
M	200	PJ	MPC	>25	STA		3	200		.08	.12	1.50	.015
N	50	PJ	MPC	>25	CRT		3	50		.08	.12	3.88	.034
O	150	SS	MPC	0-15	CRT		4	100		.10	.10	2.50	.060
P	25	SS	MPC	16-25	CRT		4	25		.10	.10	3.88	.060
Q	425	SB	BC	0-15	STA		4	125		.10	.10	0.88	.010
R	150	SS	BC	0-15	CRT		4	150		.10	.10	2.50	.060
S	50	SS	BC	16-25	CRT		4	50		.10	.10	3.88	.060
29A	2700	MS	MPC	0-15	STA		2	75	75	.13	.20	0.75	.010
B	300	MS	MPC	16-25	STA		2	25	25	.13	.20	1.13	.010
C	50	MS	MPC	16-25	MOD		2			.13	.20	1.75	.017
D	50	PJ	MPC	16-25	STA		3			.02	.03	2.25	.025
E	50	PJ	MPC	0-15	STA		3	25	25	.02	.03	1.75	.025

Allotment/ response units	Grazing Management				Brush Control Management				Coal Mining		
	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Tons/ acre	Run-off	Sediment
D	.0120	1.020	.025	No change							
E	.0080	0.466	.030	No change							
F	.0080	0.577	.025	No change							
G	.0100	0.679	.025	No change							
H	.0120	1.020	.025	No change							
25A	.0080	0.575	.025	No change							
26A	.0030	0.679	.025	No change							
B	.0120	1.190	.025	No change							
27A	.0080	0.577	.025	No change							
B	.0100	0.679	.025	No change							
C	.0120	1.190	.025	No change							
28A	.0120	0.660	.103	No change	.010	0.560	.26	.16			
B	.0120	0.936	.103	No change	.010		.26	.16			
C	.0080	0.375	.183	No change					31,000	.06	2.25
D	.0080	0.560	.183	No change					31,000	.06	3.13
E	.0080	0.820	.183	No change					31,000	.06	3.88
F	.0080	0.470	.153	No change					31,000	.06	2.25
G	.0080	0.750	.153	No change					31,000	.06	3.13
H	.0080	1.050	.153	No change					31,000	.06	3.88
I	.0120	0.660	.103	No change	.010	0.560	.22	.16			
J	.0270	1.690	.103	No change	.024	1.130	.22	.16			
K	.0120	0.936	.103	No change	.010	0.810	.22	.16			
L	.0270	2.340	.103	No change	.024	1.570	.22	.16			
M	.0120	1.400	.103	No change	.670	1.050	.22	.16			
N	.0270	3.340	.103	No change	.024	1.940	.22	.16			
O	.0480	1.870	.123	No change	.042	1.250	.24	.14			
P	.0480	2.850	.123	No change	.042	1.940	.24	.14			
Q	.0080	0.660	.123	No change	.007	0.560	.24	.14			
R	.0480	1.870	.123	No change	.042	1.250	.24	.14			
S	.0480	2.850	.123	No change	.042	1.940	.24	.14			
29A	.0080	0.560	.153	No change							
B	.0080	0.850	.153	No change							
C	.0140	1.300	.153	No change							
D	.0200	1.690	.043	No change	.018	1.440	.16	.07			
E	.0200	1.300	.043	No change	.018	1.120	.16	.07			

Allotment/ response units	Grazing Management				Brush Control Management				Coal Mining		
	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Tons/ acre	Run-off	Sediment
F	.0120	0.850	.043	No change	.0110	0.740	.16	.07			
G	.0080	0.936	.123	No change	.0070	0.810	.24	.14			
H	.0140	1.300	.123	No change	.0120	1.280	.24	.14			
I	.0140	1.300	.123	No change	.0120	0.980	.24	.14			
J	.0140	2.300	.123	No change	.0120	1.750	.24	.14			
K	.0080	0.850	.153	No change							
L	.0080	0.560	.153	No change							
M	.0120	1.300	.043	No change	.0100	0.980	.17	.07			
N	.0200	1.690	.043	No change	.0180	1.440	.17	.07			
30A(N)	.0080	0.660	.130	No change	.0070	0.620	.26	.15			
B	.0120	0.850	.050	No change	.0100	0.790	.26	.16			
C	.0200	1.320	.050	No change	.0190	1.230		.16			
D	.0080	0.550	.180	No change					31,000	.06	2.25
E	.0140	1.100	.180	No change					31,000	.06	3.13
F	.0080	0.470	.180	No change			.25	.15	31,000	.06	3.88
30A(S)			.015	No change			.17	.08			
B			.015	No change			.17	.08			
C			.015	No change							
D			.030	No change							
E			.033	No change							
F			.033	No change							
G			.033	No change							
H			.033	No change							
I			.033	No change			.16	.14			
J			.033	No change			.13	.07			
K			.033	No change			.13	.07			
L			.033	No change			.13	.07			
M			.033	No change			.13	.07			
31A	.0200	1.810	.033	No change	1.750	1.600	.13	.07			
B	.0240	2.120	.033	No change	1.960	1.870	.13	.07			
C	.0200	1.810	.033	No change	1.750	1.600	.13	.07			
32A	.0200	1.810	.015	No change			.16	.14			
B	.0480	6.370	.015	No change			.16	.14			
C	.0080	1.510	.030	No change	1.280	1.130	.16	.14			
D	.0240	5.310	.030	No change	4.360	4.690	.16	.14			
E	.0280	6.370	.030	No change	5.250	5.620	.16	.14			

Allotment/ response units	Acres	Vegetation	Soil	Slope	Erosion class	Acres of coal	Scenic rating	Acres deer winter range	Acres elk winter range	Current Management: AUM's grass forbs/acre	AUM's Browse/ acre	Tons sediment /acre	Acre feet H_2O/acre
F	25	PJ	MPC	0-15	STA		3			.02	.03	1.13	.015
G	25	SB	MPC	16-25	STA		4	25	25	.10	.10	1.25	.010
H	25	SB	MPC	16-25	MOO		4	75	75	.10	.10	2.00	.017
I	75	SB	MPC	0-15	MOO		4	50	50	.10	.10	1.50	.017
J	50	SB	MPC	>25	MOD		4			.10	.10	2.50	.017
K	100	MS	BC	16-25	STA		2			.13	.20	1.13	.010
L	25	MS	BC	0-15	STA		2			.13	.20	0.75	.010
M	50	PJ	BC	16-25	STA		3			.02	.03	1.50	.015
N	50	PJ	BC	16-25	MOO		3			.02	.03	2.25	.025
30A(N)	75	SB	BC	0-15	STA		4	75		.10	.10	0.88	.010
B	50	PJ	MPC	0-15	STA		3	50		.02	.03	1.13	.015
C	25	PJ	MPC	0-15	MOO		3	25		.02	.03	1.75	.025
D	725	MS	MPC	0-15	STA		2	725	300	.14	.10	0.75	.010
E	125	MS	MPC	0-15	MOO		2	125		.14	.10	1.50	.017
F	200	MS	MPC	16-25	STA		2	200	150	.14	.10	0.63	.010
30A(S)	75	GW	BC	0-15	CRT		4			.06	.10		
B	75	SS	BC	0-15	STA		4	75		.08	.10		
C	75	SS	BC	0-15	CRT		4	75		.08	.10		
D	50	SB	BC	16-25	CRT		4			.10	.10		
E	525	PJ	BC	0-15	STA		3	375		.02	.03		
F	175	PJ	BC	16-25	STA		3	50		.02	.03		
G	250	PJ	BC	0-15	CRT		3	175		.02	.03		
H	25	PJ	BC	0-15	CRT		3			.02	.03		
I	25	PJ	BC	16-25	CRT		3			.02	.03		
J	925	PJ	MPC	0-15	STA		3	375		.02	.03		
K	175	PJ	MPC	16-25	STA		3	50		.02	.03		
L	25	PJ	MPC	0-15	MOO		3	25		.02	.03		
M	50	PJ	MPC	16-25	MOO		3	25		.02	.03		
31A	50	PJ	BC	0-15	MOO		3	50		.02	.03	2.13	.025
B	25	PJ	BC	16-25	MOD		3	25		.02	.03	2.50	.028
C	50	PJ	MPC	0-15	MOD		3	50		.02	.03	2.13	.025
32A	275	SS	BC	0-15	STA		4			.08	.10	2.13	.025
B	250	SS	BC	0-15	CRT		4			.08	.10	7.50	.060
C	50	SB	BC	0-15	STA		4			.10	.10	1.78	.010
D	100	SB	BC	0-15	CRT		4			.10	.10	6.25	.030
E	50	SB	BC	16-25	CRT		4			.10	.10	7.50	.035

Allotment/ response units	Acres	Vegetation	Soil	Slope	Erosion class	Acres of coal	Scenic rating	Acres deer winter range	Acres elk winter range	Current Management: AUM's grass forbs/acre	AUM's Browse/ acre	Tons sediment /acre	Acre feet H_2O/acre
F	50	PJ	BC	0-15	STA		3			.02	.03	1.48	.015
G	150	PJ	BC	0-15	CRT		3			.02	.03	5.25	.034
H	50	PJ	BC	16-25	CRT		3			.02	.03	6.25	.037
I	150	GW	DS	0-15	STA		4			.06	.10	3.13	.025
J	100	GW	DS	0-15	CRT		4			.06	.10	11.00	.060
K	275	SS	DS	0-15	STA		4			.08	.10	3.13	.025
L	1325	SS	DS	0-15	CRT		4			.08	.10	11.00	.060
M	1025	SB	DS	0-15	STA		4			.10	.10	2.50	.010
N	125	SB	DS	0-15	CRT		4			.10	.10	9.00	.030
O	25	PJ	DS	0-15	CRT		3			.02	.03	9.00	.034
33A	50	PJ	MPC	0-15	STA		3	50		.02	.03		
B	25	PJ	MPC	16-25	STA		3	25		.02	.03		
C	350	PJ	BC	0-15	STA		3	350		.02	.03		
D	100	PJ	BC	0-15	CRT		3	100		.02	.03		
34A	900	PJ	BC	0-15	STA		3			.02	.03		
B	100	PJ	BC	16-25	STA		3			.02	.03		
35A	850	PJ	BC	0-15	STA		3			.02	.03		
B	150	PJ	BC	16-25	STA		3			.02	.03		
C	25	PJ	BC	>25	STA		3			.02	.03		
36A	225	PJ	BC	0-15	STA		3			.02	.03		
B	125	PJ	BC	16-25	STA		3			.02	.03		
37A	50	SS	BC	0-15	STA		4			.08	.10		
B	175	SS	BC	0-15	CRT		4			.08	.10		
C	200	PJ	BC	0-15	CRT		3			.02	.03		
D	25	SS	DS	0-15	STA		4			.08	.10	3.13	.025
E	350	SS	DS	0-15	CRT		4			.08	.10		
F	125	SB	DS	0-15	STA		4			.10	.10	3.50	.010
38A	75	SS	DS	0-15	CRT		4			.08	.10		
39A	150	SB	DS	0-15	CRT		4			.10	.10	9.00	.030
B	350	SS	DS	0-15	CRT		4			.08	.10	11.00	.050
C	375	SB	DS	0-15	STA		4			.10	.10	3.13	.010
40A	1625	SS	DS	0-15	CRT		4			.08	.10		
B	150	SB	DS	0-15	CRT		4			.10	.10	9.00	.030
C	350	SB	DS	0-15	STA		4			.10	.10	3.13	.010
41A	125	SS	DS	0-15	CRT		4			.08	.10	11.00	.060

Allotment/ response units	Grazing Management				Brush Control Management				Coal Mining		
	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Run-off	Sediment	Grass & forb AUM's	Browse AUM's	Tons/ acre	Run-off	Sediment
F	.012	1.260	.033	No cnange	1.04	1.110	.13	.07			
G	.027	4.460	.033	No change	3.67	3.940	.13	.07			
H	.029	5.310	.033	No change	4.36	4.690	.13	.07			
I	.020	2.660	.015	No change							
J	.048	9.350	.015	No change							
K	.020	2.660	.015	No change							
L	.048	9.350	.015	No change							
M	.008	2.120	.030	No change	.007	1.870	.20	.14			
N	.024	7.650	.030	No change	.021	6.740	.20	.14			
O	.027	7.650	.033	No change	.024	6.740	.13	.07			
32A			.033	No change			.13	.07			
B			.033	No change			.13	.07			
C			.033	No change			.13	.07			
D			.033	No change			.13	.07			
34A			.033	No change			.13	.07			
B			.033	No change			.13	.07			
35A			.033	No change			.13	.07			
B			.033	No change			.13	.07			
C			.033	No change							
36A			.033	No change			.13	.07			
B			.033	No change			.13	.07			
37A			.015	No change							
B			.015	No change							
C			.033	No change							
D	.020	2.660	.015	No change							
E			.015	No change							
F	.008	2.120	.030	No change	.007	1.879					
38A			.015	No change							
39A	.024	7.650	.030	No change	.021	6.750	.20		.14		
B	.042	9.350	.015	No change							
C	.008	2.660	.030	No change	.007	2.350	.20		.14		
40A			.015	No change							
B	.024	7.650	.030	No change	.021	6.750	.20		.14		
C	.024	2.660	.030	No change	.007	2.350	.20		.14		
41A	.042	9.350	.015	No change							

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